PALEONTOLOGY LIBRARY
Museum of Comparative Zoology
QE
701
J8

Volume 5 SEPTEMBER 1931 Number 3

JOURNAL OF PALEONTOLOGY

A Publication of the Society of Economic Paleontologists and Mineralogists,
a Division of
The American Association of Petroleum Geologists

CONTENTS

The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: The Subulitidae — *J. Brookes Knight* 177

New Conodonts from the Woodford formation of Oklahoma — *C. L. Cooper* 230

Conodonts from the Fort Scott limestone of Missouri — *Frank H. Gunnell* 244

Primitive Fusulinids of the Mid-Continent Region — *John W. Skinner* 253

New Schizophoriidae and a Trilobite from the Kansas Pennsylvanian — *Norman D. Newell* 260

Pulmonate Mollusca peculiar to the Pleistocene Period, particularly the Loess Deposits — *Frank Collins Baker* 270

PALEONTOLOGICAL NOTES

The Value of Fossil Fragments — *Jerome S. Smiser* 293

New Information on the Base of the Permian in North Central Texas — *Robert Roth* 295

JOURNAL of PALEONTOLOGY

RAYMOND C. MOORE, EDITOR

ASSOCIATE EDITORS

JOSEPH A. CUSHMAN
Sharon, Massachusetts

JOHN B. REESIDE, JR.
Washington, D. C.

CARL O. DUNBAR
New Haven, Connecticut

T. WAYLAND VAUGHAN
La Jolla, California

G. DALLAS HANNA
San Francisco, California

WENDELL P. WOODRING
Pasadena, California

The Journal of Paleontology is published quarterly by the Society of Economic Paleontologists and Mineralogists, a division of The American Association of Petroleum Geologists. Numbers are issued in March, June, September and December.

The subscription price of the JOURNAL OF PALEONTOLOGY is $6.00 per year prepaid to addresses in the United States, Mexico, Cuba, Porto Rico, Panama Canal Zone, Republic of Panama, Dominican Republic, El Salvador, Bolivia, Colombia, Honduras, Nicaragua, Peru, Hawaiian Islands, Philippine Islands, Guam, Samoan Islands.

Single numbers, $2.00 each.

Postage is charged extra: For Canada, 20 cents on annual subscriptions (total $6.20), and for all other countries in the Postal Union, 40 cents on annual subscriptions (total $6.40).

Claims for non-receipt of preceding numbers of the JOURNAL must be sent to the secretary-treasurer within three months of the date of publication in order to be filled gratis.

The JOURNAL will furnish reprints at cost. Orders should accompany corrected galley proof.

Communications about the JOURNAL, subscriptions, rates, memberships, change of address, and advertising should be addressed to GAYLE SCOTT, Secretary-Treasurer, Texas Christian University, Fort Worth, Texas.

Communications in regard to manuscripts or purely editorial matters should be addressed to RAYMOND C. MOORE, Editor, University of Kansas, Lawrence, Kansas.

Published at Tulsa, Oklahoma

Entered as second-class matter at the Post Office at Fort Worth, Texas, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized March 9, 1923.

MID-WEST PTG. CO., TULSA, OKLA., U. S. A.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 177-229, PLS. 21-27, 3 TEXT FIGS., SEPTEMBER, 1931

THE GASTROPODS OF THE ST. LOUIS, MISSOURI, PENNSYLVANIAN OUTLIER: THE SUBULITIDAE

J. BROOKES KNIGHT
Peabody Museum, Yale University, New Haven, Connecticut

ABSTRACT

This paper deals with that difficult group of Pennsylvanian gastropods that have at various times been referred to the genera *Macrocheilus* (= *Macrochilina*), *Soleniscus*, *Sphaerodoma*, *Bulimorpha* and others. Shell morphology particularly pertinent to this group is discussed and illustrated. It is concluded that *Macrochilina schlotheimi* (d'Archiac and de Verneuil), chosen to represent this group was siphonate, as besides a rather distinct siphonal notch it carries on its columella a fold similar to that which accompanies the siphon of recent siphonate gastropods. This fold is designated the "siphonal fold."

The complicated generic synonymy of the group is discussed, and after eliminating homonyms and synonyms (*Strobeus* de Koninck and *Sphaerodoma* Keyes are held to be strict synonyms of *Macrochilina* Bayle) five names remain. These are *Soleniscus* Meek and Worthen 1860, *Macrochilina* Bayle 1880, *Bulimorpha* Whitfield 1882, *Cylindritopsis* Gemmellaro 1890 and *Auriptygma* Perner 1907. The genotype of each of these is discussed and it is concluded that only two genera need be recognized. These are *Soleniscus* and *Auriptygma*. *Soleniscus*, however, may be conveniently and naturally divided into four subgenera, *Macrochilina*, *Bulimorpha*, *Soleniscus* (ss) and *Cylindritopsis*, of which *Macrochilina* is regarded as the more generalized stem derived out of *Auriptygma*.

The relationship of these genera to the Subulitidae Lindström is discussed and they are referred to that family. The Subulitidae are further divided into two subfamilies, the Subulitinae and the Soleniscinae. A new genus, *Ceraunocochlis*, is proposed for certain newly described Pennsylvanian species and this new genus placed in the Subulitinae while the genera *Auriptygma* and *Soleniscus* are placed in the Soleniscinae.

The genera *Auriptygma* and *Soleniscus*, and the subgenera *Macrochilina*, *Bulimorpha*, *Soleniscus* (ss) and *Cylindritopsis* are redescribed in the light of this study, and the new genus, *Ceraunocochlis*, is described.

American Pennsylvanian species referable to these genera and subgenera are discussed and on the basis of certain neglected criteria, restudies of the types of many of the species and studies of the writer's large suites of unusually well preserved specimens, many of the names in current use are referred to synonymy. Seven new species are described, one referable to *Soleniscus*, subgenus *Macrochilina*, one to *Soleniscus* subgenus *Cylindritopsis*, three to *Auriptygma*, and two to *Ceraunocochlis*.

The species described, the genotype species, and the holotypes of many of the American species including a few not redescribed in detail, are illustrated.

INTRODUCTION

C. A. White in 1884 (1, p. 149) began his discussion of the genera *Macrocheilus* and *Soleniscus* with the following remarks:

> No more confusion probably exists in relation to any group of fossil shells than is to be found among those which have been referred to the genus *Macrocheilus*..... Not only have shells of doubtful and diverse character been referred to that genus by different authors, but much uncertainty also exists as to the specific identity of the forms to which various specific names have been given.

Girty in 1915 (2, p. 191), thirty-one years later, prefaces his remarks on the same group of shells with the following:

> The shells of this group, most of which at one time or another have been cited under the generic title of *Macrocheilus*, have presented difficulties to all the paleontologists who have dealt with them and have been the subject of wide differences of opinion.

In spite of the more or less detailed considerations of this group by White (1), Keyes (3) and Girty (2) in this country and the more general considerations of several European workers of the same period (de Koninck, Koken, Cossman, Perner), these conditions have hardly been bettered today. Insofar as the above named workers failed to throw light on many of the perplexities, the failure was due chiefly to the fact that they worked almost entirely from the literature and hence have tended to perpetuate previous errors of observation and interpretation. For example, differences of opinion as to the true characters of *Soleniscus typicus* Meek and Worthen formed the basis of several misunderstandings.

As will have been inferred from the preceding, this paper will deal with a group of species many of which have in the past been referred to *Macrocheilus* and which today stand in the literature of the American Pennsylvanian under *Sphaerodoma*, *Soleniscus*, *Bulimorpha* and related genera. In the European literature similar and closely related forms appear under *Macrochilina*, *Auriptygma* and *Cylindritopsis*. All of these forms have in common a more or less robust shape somewhat produced anteriorly, little or no ornamentation and certain apertural characters including a fold on the columella and a more or less well defined anterior notch. These last two characters, as will be shown, seem to point to the possession of a siphon, which in turn would seem to ally the Paleozoic forms possessing such an organ to the Subulitidae. The Subulitidae may be briefly defined as a family of Paleozoic siphonate gastropods with little or no shell sculpture.

It is indeed a difficult group of genera to work with. The generic nomenclature is complicated with numerous homonyms and with synonyms of other generic names both within and without the family, and the characters of the genotypes on which many of the names are based have been greatly misunderstood.

Even greater confusion prevails among the numerous specific names given American Pennsylvanian forms. This is in part due to the failure of some of the earlier workers to adequately diagnose and illustrate their species. In fact some of the names rest on brief, inadequate diagnoses,

without illustrations, without present existing types and based on specimens for which only the broadest of stratigraphic and geologic occurrences were given. But for the most part the confusion is due to the inherent difficulties of discriminating accurately species in a group with so few distinctive characters, especially, as seems generally to have been the case, when such discrimination was attempted on the basis of only a few, often poorly preserved specimens. This will be taken up in detail when the American Pennsylvanian species are discussed.

SHELL MORPHOLOGY

The shells of many gastropods including the group before us show on the columella or on the parieta wall one or more, more or less distinct, revolving folds. These are too often viewed as meaningless sculptures, analogous to the often meaningless external scuplture. Some folds may be properly so regarded, but there is one type of columellar fold that is always associated with a siphonal canal or a siphonal notch. The presence of a siphon is reflected in the shell by a canal or notch, even though an ill-defined one. Even more significant for the present discussion is a spiral *channel* bounded by the right, anterior wall of the shell (in dextral species) and a spiral fold of the columella, which delimits the path, as it were, of the siphon. This particular type of columellar fold will in this paper be called the siphonal fold. It is an almost necessary accompaniment of a siphon and, conversely, when such a fold is found on fossil species it is almost compulsory to conclude that the animal possessed a siphon.

On Plate 26, figures 6a, b, c, d, e, and f illustrate the siphonal notches and folds of two species of the genus *Nassa* common on the New England littoral. Comparison of the figures of the Devonian species *Macrochilina schlotheimi* (figs. 7a, b, and c on the same plate) illustrates how closely the Paleozoic form resembles the Recent in these particulars. It seems reasonable to suppose that the almost identical structures in the shells of *Macrochilina* and of *Nassa* point to homologous structure in the soft parts associated with them. In other words *Macrochilina* was siphonate and the fold on its columella is to be regarded as a siphonal fold.

Some of the forms of the group under consideration display what is called a callus; others do not and the presence of such a character as against its seeming absence is apt to be stressed. In fact the very use of such a term implies greater differences between forms possessing it and those that do not than would a less absolute expression corresponding more

closely with nature. The surface of the mantle of the vast majority of spirally coiled gastropods in which the whorls are in close contact secretes a layer of shell over the base of the previous whorl. This layer of shell may or may not extend out far enough to be easily seen at the aperture. Sometimes it is exceedingly thin, sometimes of only moderate thickness, or again it may be quite thick. But in all cases it is morphologically one and the same thing. When it is thick it is commonly called a "callus"; when it is thin it is ignored, thus implying the presence or absence of an essential character, whereas the difference is only one of degree, and reflects no essential difference in the soft parts.

Another feature that occurs on some gastropods, a thick deposit of shell material that extends out beyond the inner lip and fills partially or completely an otherwise open umbilicus is also called a callus, although it seems to be a character of greater significance than a mere thickening of a layer which is nearly always present. It seems that the term *callus* should be restricted to this latter type of thing which is so well exemplified in *Neverita duplicata* of our eastern seaboard. I shall in this paper call the layer of shell that is nearly always found covering the parietal wall of gastropods the *inductura* (Latin—a layer, a covering).

Now the inductura of *M. schlotheimi* (pl. 26, fig. 7a, b and c) is not easily visible when the aperture is unbroken; it is thickened moderately and is molded posteriorly to form a second very low obscure fold on the parietal wall parallel to the siphonal fold. The edge of the outer lip meets the next preceding whorl at a sharp angle, but as the shell is thickened further within the aperture by deposits from the mantle surface on both sides of this angle, it becomes rounded out. The mantle itself, therefore, must have had a sharp fold at its posterior margin, i. e., a weakly developed excurrent siphon.

In *M. arculata* (pl. 26, fig. 8) from the same horizon and locality as *M. schlotheimi* the excurrent siphonal part of the mantle seems to have been rather broad and relatively rounded, thus forming the more prominent shoulder of the examples referable to that species. In the examples referable to *M. schlotheimi* this shoulder finds only slight expression. In still other examples from the same horizon and locality the fold seems to have been quite sharp, producing no shoulder whatever.

GENERIC SYNONYMS AND HOMONYMS

Many generic names have been proposed for members of this group and their synonymies are complicated by an unusually large number of homonyms. To clear the field, I shall cite the full list as far as I have

been able to ascertain it. Though members of the group have appeared under the generic appelation of *Buccinum*, *Buccinites*, *Polyphemus*, *Loxonema* and perhaps under other names that are as obviously inapplicable, I shall begin our list with *Macrocheilus*, the first generic name that came into general use specifically for any of the group.

Macrocheilus Phillips 1841 (4, p. 103). Genotype by subsequent designation *Buccinum arculatum* Schlotheim (5, p. 127) (not *Macrocheilus* Kirby 1838.)

Plectostylus Conrad 1842 (7, p. 275). Genotype by original designation *Plectostylus hildrethi* Conrad. (Not *Plectostylus* Peck 1837).

Polyphemopsis Portlock 1843 (8, p. 415). Genotype by subsequent designation, *Polyphemopsis elongatus* Portlock (9, p. 423; 10, p. 299. *P. elongatus* is quite certainly a *Subulites*, and hence Portlock's name becomes a synonym of *Subulites*. *Polyphemus fusiformis* Sowerby seems to have been the species upon which Portlock intended founding his name, but as he neither designated nor indicated a genotype under the required rigid constructuion of the rules, and as *P. elongatus* was subsequently designated in strict conformance therewith, the action is irrevocable. *P. fusiformis* seems to be a valid member of the group we are considering.

Bulimella Hall 1858 (12, p. 29). Genotype by original indication *B. bulimiformis* Hall. (Not *Bulimella* Pfeiffer 1854).

Soleniscus Meek and Worthen 1860 (13, p. 467). Genotype by original designation, *S. typicus* Meek and Worthen.

Duncania Bayle 1879 (14). Genotype by original designation *Buccinum arculatum* Schlotheim. (Not *Duncania* de Koninck 1874).

Macrochilina Bayle 1880 (15). Genotype by original designation *Buccinum arculatum* Schlotheim.

Strobeus de Koninck 1881 (16, p. 25). Genotype by subsequent designation, *S. ventricosus* de Koninck (26, p. 102). (Not *Macrocheilus ventricosus* Hall 1858.)

Bulimorpha Whitfield 1882 (17, p. 74). Genotype by original designation, *Bulimella bulimiformis* Hall.

Sphaerodoma Keyes 1889 (3, p. 305). Genotype by subsequent designation, *Stylifer primogenia* Conrad (2, p. 192).

Cylindritopsis Gemmellaro 1890 (19, p. 53). Genotype by subsequent designation, *C. ovalis* Gemmellaro (26, p. 104).

Auriptygma Perner 1907 (20, p. 361). Genotype by subsequent designation, *A. fortior* Barrande (26, p. 106).

Eliminating homonyms and synonyms of genera not included in the list, we have to deal with seven names. These are, in order as proposed: *Soleniscus* Meek and Worthen (1860), *Macrochilina* Bayle (1880), *Strobeus* de Koninck (1881), *Bulimorpha* Whitfield (1882), *Sphaerodoma* Keyes (1889), *Cylindritopsis* Gemmellaro (1890) and *Auriptygma* Perner (1907).

THE GENOTYPE SPECIES

We will next consider the species upon which each of these names is founded, but instead of taking them up in the order of nomenclatorial priority it will be profitable to consider the geologically older species first and to continue on that plan.

Auriptygma fortior Barrande) from the Silurian of Bohemia is the oldest from the geological standpoint. It is unfortunate that no authentic example of this species is at hand and that Perner's illustrations leave something to be desired. And yet it seems clear from Perner's remarks taken in connection with his illustrations that we have to deal with a species with characters much as in *Macrochilina* but that these characters are relatively undeveloped. It has, like *Macrochilina*, a robust form and a revolving fold on the columella, though its columellar fold is very low and indistinct in comparison with the well developed one of *Macrochilina*. There is no trace of a second fold back of the first. Though Perner does not discuss it, the inductura on the parietal wall is probably very thin, if not actually wanting. Its sutures are considerably deeper than in *Macrochilina*. Perner's illustrations of *A. fortior* are reproduced on Plate 26, figure 9 and Plate 27, figure 2.

The genotype of *Macrochilina*, *Macrochilina arculata* (Schlotheim) is from the Stringocephalus beds of Middle Devonian age at Paffrath, Germany.

I have been fortunate in being able to study specimens in the Yale collections from its type locality. However, none of the ten large robust specimens of *M. arculata* before me have apertures sufficiently well preserved to illustrate the all-important apertural characters as do many specimens of the more slender variant which has appeared in the literature under the name *M. schlotheimi* (d'Archiac and de Vernueil). These two forms associated in the same beds have identical apertural characters and seem to intergrade completely. Indeed the latter name is today generally held to be a synonym of the former. At any rate whether *M. schlotheimi* be regarded as a variant of *M. arculata* or as a separate but closely related species, it is unquestionably congeneric. Hence there can be no danger in using it to illustrate the characters of Bayle's genus.

A specimen of *M. arculata* is shown on Plate 26, fig. 8. *M. schlotheimi* is illustrated by figures 7a, b and c on the same plate, and as may be seen has a well developed siphonal fold and a second, low, obscure fold in the inductura on the parietal wall. If one compares the apertural characters of *M. schlotheimi* with those of the two species of recent siphonate genus *Nassa* figured on the same plate it is impossible to avoid the conclusion that the Devonian form was siphonate as well.

M. schlotheimi differs from *Auriptygma fortior* in the greater development of the siphonal fold, and in the possession of a second low fold on the parietal wall. Its sutures are also less deeply impressed. The genera based on these two species may be regarded as related, yet distinct.

Strobeus ventricosus de Koninck from the Viséan limestone of Mississippian age in Belgium will next receive consideration. Although it is to be regretted that no specimen of this species is available for study, there can be little doubt from the study of de Koninck's somewhat overdrawn figure (reproduced on pl. 26, fig. 5a, b) that *S. ventricosus* is congeneric with *M. arculata* and that *Strobeus* is a synonym of *Macrochilina*. This conclusion is strengthened by a perusal of de Koninck's diagnosis and his remarks. He seems to have been laboring under the misconception that the inductura of *Macrochilina* is confined to the columella and is wanting on the parietal wall, which, as we have just seen, is not the case. The inductura of *S. ventricosus* is, it is true, somewhat thicker than that of *M. schlotheimi*, but if genera are to be made on such minor differences in degree of development of so variable a character, then each species must become a genus.

The next species that will occupy our attention is *Bulimorpha bulimiformis* (Hall). This is an American Mississippian species from the Spergen limestone and I have quite a number of topotype specimens at my disposal. It is a smaller and much more slender form than those we have hitherto dealt with, but aside from its slenderness it has many of their more essential characters. Two specimens are figured on Plate 26. It will be noted in figure 4b that it has a siphonal fold, albeit the fold is placed well forward, as is the siphonal notch Evidently the siphon was exceedingly slender. The columella is strongly arcuate. The inductura is thin and although covering the parietal wall shows no second fold. Thus, except for slender form and other minor differences which seem to be correlated with slender form, there is little to separate generically *Bulimorpha bulimiformis* and *Macrochilina arculata*. Girty seems effectually to have put to rest the notion that slenderness of form is

either a natural or practical basis for generic separation (2, p. 194) in this group, however significant it may be in others.

Sphaerodoma primigenia (Conrad) from the American Pennsylvanian is illustrated on Plate 22, figures 2a-j. Its close similarity to *Strobeus ventricosus* de Koninck and *Macrochilina a culata* will be noted at once. It is somewhat more ventricose than the latter and its siphonal channel is wider. In these respects it agrees closely with the former. A possible difference is the great amount of secondary shell deposit within the spire of *S. primigenia*. It is not known whether this tendency finds expression in *Macrochilina* but it seems of minor importance in any case.

Soleniscus typicus is also from the American Pennsylvanian. The exact characters of this species have been the subject of much discussion and have not heretofore been understood. I have had the privilege of examining Meek and Worthen's holotype (the figured specimen) and a paratype. I also have in my own collections many specimens of the species.

Meek and Worthen's types are illustrated on Plate 22, figs. 1e and f and several of my own specimens are on the same plate. There is also shown as figure 1k on the same plate a composite drawing that will help to illustrate the characters of the species. It has a narrow siphonal notch which, being narrow, is situated well forward. The trace, as it were, of the angular projection forming the right hand margin of the siphonal notch forms on the columella a low, rounded, siphonal fold. Behind the siphonal fold and separated from it by a narrow groove is a second fold, much more elevated and conspicuous than the siphonal fold when seen on broken specimens such as Meek and Worthen's types. This second, posterior fold is formed shortly within the aperture and hence on specimens with unbroken outer lips and matrix-filled apertures is wholly invisible or only to be seen as an inconspicuous outbending of the outer lip.

It seems reasonable to homologize the siphonal fold of *S. typicus* with the corresponding fold of the forms hitherto considered and the second, posterior fold with the obscure fold on the parietal wall of *Macrochilina schlotheimi*. In *S. typicus*, as in *Bulimorpha bulimiformis*, the anteriorly drawn-out form of the body and the relatively narrow siphon brings the anteriorly placed organs relatively farther forward in the shell; hence the posterior fold of *S. typicus* appears on the columella at the base of the parietal wall and not farther back on that wall itself as does the homologous undeveloped fold of *M. schlotheimi*, or on the fully developed one on the parietal wall shown by *Cylind itopsis ovalis*, next

to be discussed. There is in *Soleniscus typicus* some deposition of secondary shell matter within but not nearly to the extent as in *Sphaerodoma primigenia.*

The last species to engage our attention is *Cylindritopsis ovalis* Gemmellaro from the Permian of Sicily. Here again I am forced to rely on the literature as no example of the species is available. But fortunately Gemmellaro's illustrations are of a superior order. They are reproduced as figures 3a, b on Plate 26. *C. ovalis* is, as its name implies, oval in shape with a relatively short spire and large body whorl. It has two well developed columellar folds. One the siphonal fold, is placed anteriorly and the second well up on the parietal wall. The inductura seems to be moderately thickened. We seem to have in this instance the rudimentary posterior fold of *Macrochilina* finding its full expression but without the crowding forward seen in *Soleniscus.*

CONCLUSIONS AS TO VALID GENERA

From the foregoing consideration of the typical species upon which the seven generic names are based it seems possible to make the following deductions. First, that we are dealing with a natural group in which the progressive development of a true siphon seems evident. Secondly, that parallel with the development of the siphon and its concomitant siphonal fold there appears a tendency to develop a second, posterior fold which is only obscurely developed in *Macrochilina schlotheimi* but which finds full expression under slightly different aspects in two of the forms, *Soleniscus typicus* and *Cylindritopsis ovalis.* Thirdly, that certain of the genotype species are so closely related that their generic names must be regarded as strict synonyms.

It will simplify further discussions if the strict synonyms be first eliminated. There seems no valid ground for holding separate *Macrochilina*, *Strobeus* or *Sphaerodoma.* If grounds should be found to give the names of the Carboniferous forms even subgeneric rank, which seems unlikely, *Sphaerodoma* would have to yield precedence to *Strobeus.* Both *Strobeus* and *Sphaerodoma* will here be considered strict synonyms of *Macrochilina. Strobeus* has already been placed in the synonymy of *Macrochilina* by Koken (22, p. 447) and other European authors, and Girty seems to have been influenced in holding *Sphaerodoma* distinct from *Macrochilina* largely by the shouldered whorls of *M. arculata* (2, p. 196). No one who has been privileged to examine a suite of specimens from the type locality of this species would attach generic value to that character. Indeed there is so much individual variation in it

that it seems doubtful that it has even specific value. Girty seems to have given no consideration to *Strobeus*.

Auriptygma, the first of the remaining five to make its appearance in geologic time has hitherto been known from only a few Silurian species. As we have seen it has a low fold delimiting a wide, shallow channel. It seems reasonable to suppose that the fold of the mantle occupying the channel was in the nature of a wide, somewhat obscure, possibly rudimentary siphon, the very beginning of a siphon. On the parietal wall the inductura is thin and carries no suggestion of a second fold. *Auriptygma* seems to have, by virtue of its appearance in the Silurian and of its rudimentary *Macrochilina*-like characters, just what might be expected of the ancestral stock from which *Macrochilina* was derived.

Of the four remaining genotypes, all four have well developed siphonal folds and channels. In two of them, *Macrochilina* and *Cylindritopsis*, the siphon must have been relatively wide and directed obliquely to the left of the animal. In two of them, *Bulimorpha* and *Soleniscus* it seems to have been narrow and directed forward. *Macrochilina* seems to show a rudimentary posterior fold. Both *Cylindritopsis* and *Soleniscus* have a well developed posterior fold; in the case of the first which seems to include only robust forms, the posterior fold is parietal in position; in the case of the second, including only a single slender form, it, like the siphonal fold, is crowded forward. *Bulimorpha*, a slender form with a relatively thin inductura shows no posterior fold, though the siphonal fold is crowded forward as in *Soleniscus*.

These last four names seem to form a natural unit, a unit derived out of *Auriptygma* but distinct from it, a unit that is further subdivisible into natural groups that have more in common with each other than they have with other groups. It seems natural to deal with such a subdivisible unit as a single genus with four subgenera, and that plan will be followed here. *Macrochilina*, Devonian to Permian, is regarded as the stem-group, the phylogenetically typical subgenus; *Bulimorpha*, Mississippian, a short lived side branch stressing slenderness of form and thin shell; *Cylindritopsis*, a Pennsylvanian and Permian exaggeration, as it were, of the more primitive *Macrochilina* characters; and *Soleniscus*, Pennsylvanian, again exaggerating the rudimentary posterior fold of *Macrochilina* but combining with it the slender form and slender, anteriorly placed siphon of *Bulimorpha*.

Another character that seems to develop progressively in the subgenus *Macrochilina* and to be carried on into *Cylindritopsis* is the secondary thickening of the outer wall of the shell and the partial resorption

of some of the inner structures, probably to gain space lost by the thickening of the former This character may have had a survival value as the gastropods of the Carboniferous where it seems to have reached its maximum development certainly must have supplied much of the food of the mollusc-eating selachians that abounded at that time. At my best collecting locality (Locality 43) numerous fragments of these shells are found which show evidence that they were broken before fossilization. There was certainly no rock-bound, surf-beaten coast to account for these broken shells and shark remains are abundant with them.

It is in a sense unfortunate that the laws of priority require that the name *Soleniscus*, a specialized end form, becomes the nomenclatorially typical subgenus. To this extent at least nomenclature may not follow nature.

It seems possible that *Auriptygma* was derived from *Fusispira* which arose in the Ordovician and which seems not only to have possessed a siphon but a somewhat similar shape. Although the probability that *Fusispira* and its Ordovician and Silurian allies, *Subulites* and *Cyrtospira*, had a better developed siphon than *Auriptygma* seems to militate against such an hypothesis, it will be tentatively adopted here. Whether or not it is accepted it seems that the possession of a siphon, relatively of such rare occurrence in the Paleozoic, should suggest a common ancestry for those genera possessing such an organ. It seems proper that such genera be placed in the same family.

There occurs in the American Pennsylvanian still another genus of siphonate gastropods to be defined in this paper. This is *Ceraunocochlis* Knight, genotype *C. fulminula* Knight n. sp. It has much more the appearance of the Ordovician and Silurian genera *Subulites* and *Cyrtospira* than of *Auriptygma* or *Soleniscus* and it is suggested that it may have been derived independently from *Subulites*.

THE FAMILY RELATIONSHIP

The genera we have been discussing have been placed in various families by different authors. A brief review of the courses taken by some of the more prominent authorities will clear the decks for the consideration of family relationships to follow.

Lindström (11) places *Macrocheilus* in the Pyramidellidae without explanation. He recognizes the siphonate character of *Subulites* and proposes the family Subulitidae to receive it, suggesting at the same time that *Bulimorpha* and *Fusispira* probably belong there. Waagen (23, p.

96) places *Macrocheilus* (=*Macrochilina*) in the Eulimidae. His remarks in so doing illustrate his ultraconservative viewpoint, for while admitting that the shells of the genus have sometimes "an anteriorly slightly effuse aperture," he quite frankly prefers to classify shells in accordance with their general appearance.

Fischer (29, pp. 697-699) places *Macrochilina, Soleniscus* and *Strobeus* in the Pseudomelaniidae. Koken (22, pp. 446, 448) refers *Macrochilina* and *Cylindritopsis* to the Loxonematidae. Perner (20, pp. 353, 361) refers *Macrochilina* and *Auriptgyma* to the Loxonematidae, though Perner (20, p. 374) and Koken and Perner (24, p. 253) recognize the Subulitidae for *Subulites* and its closer allies. Ulrich and Scofield (25, p. 1069) recognize the Subulitidae and treat it essentially as did Lindström.

Cossman (26, p. 80) places *Macrochilina, Strobeus, Cylindritopsis* and *Auriptygma* in the Pseudomelaniidae, but *Soleniscus* (sensu stricto) and *Bulimorpha*, as a synonym of *Fusispira*, in the Subulitidae (26, p. 112). He places in both these families many other genera that do not seem to have place in them unless one is to be guided by Waagen's criterion.

The various editions of Zittel's well known Grundzüge der Paleontologie, both the German and the English editions, place most of the genera we are considering in the Pyramidellidae. However, in the first German edition it is suggested that the genera *Subulites* and *Fusispira* are characterized by narrow, anteriorly elongated and canaliculate aperture; and that they probably form a separate family, the Subulitidae. The English edition of 1900 adds *Soleniscus* (27, p. 457) and the latest German edition *Sphaerodoma* to the list (28, p. 471).

Girty (2, p. 181) places our group along with other unrelated forms in the Pyramidellidae with the statement that "while recognizing the fact that those genera probably represent more than one valid family" he is in the main following Zittel in his classification.

Thus we find some or all of our group referred to the Pyramidellidae, the Eulimidae, the Loxonematidae, the Pseudomelaniidae and the Subulitidae. Indeed, Gemmellaro referred *Cylindritopsis* to the Actaeonidae, an opisthobranch family (19, p. 53), in which action he was reversed, I think rightly, by his first reviewer (22, p. 448). As the present review makes no pretense of being exhaustive it should be unnecessary to say that other authors may have placed some or all of the group in still other families.

It seems to me rather difficult to associate the group we are discussing with any of the first four families listed in the preceding paragraph. The Pyramidellidae, considered narrowly, as I feel such matters should be, is composed of Tertiary and Recent gastropods with heterostrophic nuclei. Neither the Eulimidae nor Pseudomelaniidae, which may properly include Mesozoic genera, have a trace of a siphonal fold or a siphon. The same may be said of the Paleozoic and Mesozoic family, Loxonematidae, which is characterized principally by a certain characteristic sinuosity of the outer lip not shown in our group. To place the group with any of these families seems to so stretch the concept of a closely related unit as to do serious damage to it. Such action appears to be directly contrary to true conservatism.

There remains then of the five families considered the Subulitidae, a Paleozoic family and one in which there seems to be valid evidence of the presence of a siphon and siphonal fold, and with which our group is at variance in no essential particular. It seems reasonable then to place in this family all of the genera or subgenera we are directly considering at this time.

Thus maintaining the family name, Subulitidae Lindström for all known Paleozoic gastropods that show evidence of having been siphonate, we find within it two main lines of descent, the one leading through *Fusispira* to *Auriptygma* and *Soleniscus* with its subgenera, and the other through *Subulites* to *Ceraunocochlis*. I shall therefore consider the family Subultidae as divided into two subfamilies; the Subulitinae (new) which will include *Subulites*, *Cyrtospira*, which should probably be considered a subgenus of the former, *Fusispira* and *Ceraunocochlis*, and the Soleniscinae (new) which will include *Soleniscus* with its subgenera and *Auriptygma*. These concepts are set forth graphically in text figure 1.

Although in the preceding paragraph I seem to have limited the family Subulitidae to the Paleozoic, I have no intention of doing so. I am here considering only Paleozoic forms, as consideration of later ones would carry this study too far afield. It seems likely that Mesozoic and perhaps even later forms may properly find a place in it. It is even interesting to speculate that the Recent Rachiglossa in which the siphon reaches its fullest development may have been derived ultimately from this group, though in the present stage of our knowledge this can only be a speculation. Some members of other major groups are also siphonate and we have nothing to suggest that the Subulitids were carnivorous as are the Recent Rachiglossa.

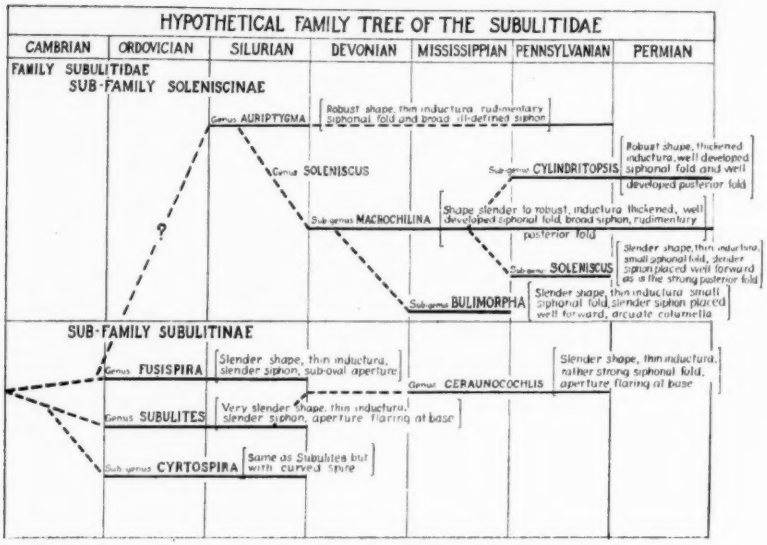

HYPOTHETICAL FAMILY TREE OF THE SUBULITIDAE
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
FAMILY SUBULITIDAE
SUB-FAMILY SOLENISCINAE
Genus AURIPTYGMA
Robust shape, thin inductura, rudimentary siphonal fold and broad ill-defined siphon
Genus SOLENISCUS
Sub-genus CYLINDRITOPSIS
Robust shape, thickened inductura, well developed siphonal fold and well developed posterior fold
Sub-genus MACROCHILINA
Shape slender to robust, inductura thickened, well developed siphonal fold, broad siphon, rudimentary posterior fold
Sub-genus SOLENISCUS
Slender shape, thin inductura, small siphonal fold, slender siphon placed well forward as is the strong posterior fold
Sub-genus BULIMORPHA
Slender shape, thin inductura, small siphonal fold, slender siphon placed well forward, arcuate columella
?
SUB-FAMILY SUBULITINAE
Genus FUSISPIRA
Slender shape, thin inductura, slender siphon, sub-oval aperture
Genus CERAUNOCOCHLIS
Slender shape, thin inductura, rather strong siphonal fold, aperture flaring at base
Genus SUBULITES
Very slender shape, thin inductura, slender siphon, aperture flaring at base
Sub-genus CYRTOSPIRA
Same as Subulites but with curved spire

FIG. 1.—Hypothetical family tree of the Subulitidae.

Text figure 2 shows a diagrammatic and hypothetical reconstruction of a generalized Pennsylvanian *Soleniscus* (sensu lato) which illustrates the concepts I have been endeavoring to set forth.

FIG. 2—Diagrammatic restoration of a generalized Pennsylvanian *Soleniscus* (sensu lato). The shell is drawn as if partly cut away to show the visceral mass and the partly filled apical whorls.

GENERIC DIAGNOSES

As we are giving the genera of this group detailed consideration for the first time in some years and as much of the consideration is based on studies of genotype material, it is hoped that a redefinition of the genera and subgenera of the Soleniscinae may not be considered presumptuous. A diagnosis of the new genus *Ceraunocochlis* of the Subulitinae is also required.

GENUS AURIPTYGMA PERNER 1907 (20, p. 361)

Lacking specimens of the genotype, the re-description of this group is derived from a reconsideration of Perner's original description, somewhat modified by an attempt to interpret his illustrations and by the study of my Pennsylvanian specimens. Perner's illustrations of *A. fortior* (20, p. 362, figs. 260, 261) are difficult to interpret and to reconcile with each other. The inner lip as shown in his text figure 261 (see pl. 26, fig. 9 of the present paper) seems to be thin and sharp and to present its thin edge to the observer for most of its length. Though such a condition may not be entirely impossible, it is certainly of rare occurrence except in umbilicate shells and *A. fortior* is not umbilicate. Again in his vertical section (his text figure 260, pl. 27, fig. 2 of the present paper) he seems to show a well developed columella extending through the inner lip, a feature difficult to reconcile with the apparent thinness of the latter as shown in text figure 261. It is also difficult to understand from figure 261 the origin of the low columellar fold shown in figure 260.

For these reasons and because my Pennsylvanian species conform closely to Perner's description of the genus and to his figures in all characters except the thin, sharp inner lip shown in figure 261, I conclude that this character has been mis-drawn by Perner's artist, either through lack of skill or through a misconception of this characte · derived from a study of imperfect material. These considerations naturally affect the following redefinition.

Auriptygma is a genus of gastropods of moderate size, turbinate form and imperforate base. The nucleus is small, smooth and turbinate and is not sharply marked off from the succeeding whorls. The moderately inflated whorls and moderately deep sutures give a well arched whorl profile. The aperture is suboval with a thin outer lip the edge of which is not sinuate. The inductura is thin and almost wanting on the parietal wall except just above its juncture with the columella. The columella is essentially straight and bears well up toward the parietal wall a low, rounded and obscure columellar fold, here interpreted as a siphonal fold. The anterior margin does not bear a distinct siphonal notch. The ornamentation consists of low, narrow transverse lirae, sometimes combined with faint revolving striae, or the shell may be smooth and without any ornamentation at all. The transverse lirae or the growth lines show the outer lip to have been nearly straight or to have passed downward and backward from the suture with a slight obliquity. On the interpretation of the low columellar fold as bordering the siphonal channel, the siphon must have been broad and short, a rudimentary siphon. The shell wall,

of the Pennsylvanian species at least, is only slightly thickened by secondary deposits, and though the apical whorls may become constricted by such deposits, only the very earliest are closed.

The genotype is *Auriptygma fortior* Barrande from the Silurian of Bohemia (pl. 26, fig. 9, pl. 27, fig. 2). The genus seems to range from the Silurian through the Pennsylvanian.

GENUS SOLENISCUS MEEK AND WORTHEN, 1860 (sensu lato)

Gastropods ranging in form from globular to fusiform. The nucleus is small, smooth and tubinate and is not sharply marked off from the succeeding whorls. The whorls are moderately inflated, rather deeply embracing and the sutures relatively shallow. The aperture is suboval to subelliptical, with a thin outer lip, the edge of which proceeds obliquely forward from the suture a short distance and then curves downward. The anterior margin shows a siphonal notch which may be broad and indistinct or may be deep and narrow and may be directed forward or obliquely to the left across the columella. The inductura varies in thickness among the subgenera and even the species but seems relatively constant in any given species. All subgenera show one well developed columellar fold which is here interpreted as a siphonal fold bordering a more or less well defined siphonal channel. All but one subgenus show a second, posterior (upper) columellar fold which varies greatly with the subgenus in the degree of development and in its relative position. A rudimentary anal siphon is indicated but there is no distinct anal notch. The surface is smooth and unornamented, or may show strong lines of growth that seem to fasciculate into weak transverse lirae.

There is a tendency for the shell to become thickened inwardly back of the thin apertural edge and in some species all but the final three or four whorls are closed by secondary shell matter. When the outer shell is greatly thickened in this way there is a tendency to resorb the inductura on the inner whorls and even the siphonal fold and to reduce the thickness of the columella.

The genotype is *S typicus* Meek and Worthen from the Pennsylvanian of Illinois.

The genus seems to range from the Devonian through the close of the Paleozoic into the Mesozoic.

SUBGENUS MACROCHILINA BAYLE 1880

Gastropods answering to the description of the genus except that the subgenus is limited to species in which the posterior columellar fold is rudimentary and represented by a broad thickening of the inductura

separated from the siphonal fold by a relatively narrow but shallow groove. So far as known those members of the genus with fasciculated growth lines resembling the fine lirae of *Auriptygma* are confined to this subgenus. Most of them are entirely unornamented. The siphonal channel is broad though distinct and directed across the base of the columella. Many species, particularly the later ones, show extreme thickening of the outer wall and resorption of parts of the inner structure.

The subgenotype is *Buccinum arculatum* Schlotheim from the middle Devonian of Germany (pl. 26, fig. 8).

Subgenus BULIMORPHA Whitfield 1882

Slender, fusiform Solenisci with subelliptical aperture, thin inductura and no posterior columellar fold; with an arcuate columella and with the siphonal fold and channel small and crowded well forward. The small siphonal notch is anterior in position and the siphon seems to have been directed forward. The thickening of the outer wall back of the aperture is slight.

The subgenotype is *Bulimella bulimiformis* Hall from the Mississippian of Indiana (pl. 26, figs. 4a-b).

This subgenus seems to be confined to the Mississippian.

Subgenus SOLENISCUS Meek and Worthen 1860 (sensu stricto)

Solenisci with slender form, sub-elliptical aperture and the siphonal fold and channel small and crowded well forward. The small siphonal notch is anterior in position and the siphon seems to have extended forward. The posterior fold is strongly developed and like the smaller siphonal fold is crowded forward so that it is situated near the base of the parietal wall. The shell is only slightly thickened back of the aperture.

The subgenotype is the same as that of the genus, *S. typicus* Meek and Worthen from the Pennsylvanian of Illinois (pl. 22, figs. 1a-k).

The subgenus seems to be confined to the Pennsylvanian.

Subgenus CYLINDRITOPSIS Gemmellaro 1890

As no example of the type of this subgenus was available, the following is drawn from Gemmellaro's diagnosis and illustrations and from the Pennsylvanian species described herein.

Solenisci of oval or globular form, sub-elliptical aperture and deeply embracing whorls. Both the siphonal and posterior folds are strongly developed, and the latter is placed well up on the parietal wall. The

inductura is moderately thickened as is the outer shell back of the aperture and considerable resorption of the inner parietal walls of the shell and of the columella takes place. The siphonal notch is deep and the siphon seems to have been directed obliquely across the columella.

The subgenotype is *C. ovalis* Gemmellaro from the Permian of Sicily (pl. 26, figs. 3a-b).

The range of this subgenus seems to be Pennsylvanian and Permian.

GENUS CERAUNOCOCHLIS KNIGHT, N. GEN.

(κεραυνός = thunderbolt, κοχλίς = small snail.)

Minute oval to fusiform gastropods with very shallow sutures, subelliptical aperture, flaring effuse anterior margin and a distinct siphonal fold and notch. The shell wall is thin and the columella and parietal walls of the earlier whorls apparently reduced by resorption. The inductura is thin. The nucleus is flattened and discoidal on top, a character that would seem to exclude the genus from the Soleniscinae, though on the other hand nothing is known of the nuclei of the early Subulitinae.

The genotype is *C. fulminula* Knight n. sp., described herein, from the Pennsylvanian of Missouri (pl. 21, figs. 1a-d).

Besides the genotype and another species here described, I would refer to the genus *Subulites harrodsburgensis* Cumings from the Spergen limestone of Indiana. The range of the genus thus seems to be Mississippian and Pennsylvanian.

DISCRIMINATION OF SPECIES

The literature dealing with the Pennsylvanian species referable to the Soleniscinae as here considered is exceedingly involved. It is cluttered with names that for practical purposes have no meaning though valid from the point of view of technical nomenclature. I have reference to the names of species described inadequately and either not illustrated at all or illustrated so poorly as to be entirely unrecognizable in a group where species are so similar as in this one.

The types upon which many or most of such meaningless names are based are scattered, some lost, some known to have been destroyed by fire. In most cases the horizons and localities from which the types were derived are stated too vaguely to offer hope of discovering topotype material and topotype material if obtainable is of doubtful value in the case of species that are as similar as these and as likely to occur several together in the same bed. Names of this sort are a constant source of difficulty. Mere synonyms are in comparison simple to deal with—if

recognizable. Such names of unrecognizable species are protected by the Rules of Nomenclature and cannot simply be dropped, but they can be advantageously relegated to a limbo of meaningless names in the small print of bibliographies, from which they may be rescued should any reason for so doing appear.

In addition to the difficulties occasioned by names of unrecognizable species the synonomies are exceedingly involved, more so than has hitherto been recognized. Some of the names here placed in synonymy have long enjoyed recognition; in several cases names coined by the same author have been suppressed even though they were originally proposed in the same publication. My justification for differing from distinguished predecessors is that they were working with few and scattered specimens, while I have many specimens most of them from a narrow stratigraphic zone at a single locality and have been able to study individual variations as well as the seeming variations due to differences of growth stage.

In this group of shells the ornamentation is so simple that specific discrimination must be made almost wholly upon general contour often reinforced by differences of apertural characters. Slight differences in general contours are met with frequently in species with a characteristic sculpture and are properly held of no significance as specific criteria. For example, a large collection of shells of the rather ornate Recent species *Nassa trivittata* shows very considerable individual variation in relative height of spire, pleural angle, degree of shouldering of the whorls, and such minor differences. And yet these differences are almost automatically discounted because very distinctive sculpture combined with apertural characters are sufficient to emphasize the specific unity regardless of minor variations in the general form.

In dealing with the Soleniscinae, however, we rarely have such obvious clues as ornamentation and are compelled to rely in large part in distinguishing species on characters which are from their very nature least distinctive and most variable. While it is desirable in general for a paleontologist to consider a large collection in establishing a species, in the case of the Soleniscinae it is almost essential that he do so.

Early in this study it was noticed that several of my then tentative fossil species were seemingly separable into two lots one slightly more robust than the other, but otherwise identical. This fact suggested sexual dimorphism. Unfortunately there seems to be in the literature but little data bearing on this question. Therefore, though mid-winter is not a favorable time for obtaining living specimens in abundance, 120 specimens of *Urosalpinx cinerea* were collected and 19 specimens of

Cycotypus canaliculatus and 28 of *Fulgar carica* were purchased from a fisherman. The sex of each specimen was determined, the shell marked, the soft parts removed[1] and an effort made to determine any differences in the shells of the series. The results are almost, but not quite, negative.

The 120 specimens of *Urosalpinx* proved to be 65 males and 55 females. The females tended to vary from a mean in the direction of a slightly wider aperture and a more strongly arched outer lip. Yet this tendency failed of definite expression in so many of the females that it was impossible to separate the sexes on the basis of it or any other shell character observed. But while this was true, when one picked out all of the specimens in which this tendency found clear expression, they proved to be females. The remainder were males and slender females. Thus, although the attempt did not provide a means of distinguishing the sexes in that species, it did suggest one possible cause of individual variation.

Among the 19 specimens of *Cycotypus canaliculatus*, 3 proved to be males and 16 females and among the 28 specimens of *Fulgur carica* 10 were males and 18 females. No differences of contour were observed but in both species the females were considerably larger than the males. If the difference in size of the two sexes in these species is constant, one wonders if the preponderance of females in the collection is not due to selection by the fisherman of the larger specimens with which to fill his commission. Collectors are quite naturally prone to select only fine large examples when specimens are numerous.

Turning again to the fossil shells, measurements of the pleural angle of a number of specimens show complete intergradation. Even in the extremes no other character is found that correlates with the variation in pleural angle and the conseqent expression of relative slenderness or robustness measured by it. Hence it is necessary to consider the whole series in each case as belonging to a single species, and to apply the same conclusions to the forms in the literature varying only in a similar way.

The very different superficial aspect of young and old shells of the same species is responsible for not a few synonyms. Here again large suites of specimens must be appealed to, for there seems to be no suddenly appearing gerontic character in this group that may be used as a criterion of old age It may be mentioned in passing, however, that there does appear to be a loss of sharpness to the columellar border of the siphonal notch as maturity is approached, though this occurs gradually and is apparently in full effect at less than half the maximum size.

[1]These dissections were performed by Mr. Marshall Bishop of Peabody Museum. His assistance is gratefully acknowledged.

Collections of Recent species were again appealed to, to determine approximately what one should expect the stage of growth of a fossil gastropod to be, and as museum collections are for the most part assembled by those interested only in fine large specimens, it was necessary to make collections especially for the purpose A brief visit to the tide pools and flats along the shore will show at once that living communities are made up of individuals of all ages since the last hatching season but with a great predominance of the younger specimens. Collections of living individuals would not suffice as a large percentage of the younger ones might presumably live to full growth, and such collections would not parallel collections of fossils.

Collections were therefore made of the dead shells of two living species abundant near New Haven. In order to eliminate the element of choice and of wave sorting as far as possible, the collections of each species were made at different points on the shore and every specimen of the given species large enough to be seen with the naked eye was collected from an area of a few square feet. The collections were made up of 351 shells of *Littorina litorea* from one station and 227 specimens of *Nassa trivittata* from the other. The length of every specimen of each species was measured as an index of the stage of growth reached at the time of its death and this length in millimeters was plotted against the number of specimens of each species, as shown in text figure 3. In the same text figure are plotted curves drawn from similar data taken from 155 specimens of the fossil species *Soleniscus* (*Macrochilina*) *regularis* and 133 of *S.* (*M.*) *paludinaeformis.*

The curves of the two fossil species do not take the same form as those for the two recent species, but this is to be expected since the method of collecting was different in each case. The collections of the fossil species were assembled by examination of the entire outcrop at the collecting locality and by washing and examining under the microscope quantities of disintegrated shales. However the four curves agree in showing that very few specimens reach or even approach the maximum size for the species, and that the great majority of specimens are of less than half the size attained by the very few.

Had collections of both recent and fossil species been made under more rigid control of collecting all specimens in a predetermined area with the aid of the microscope it would be reasonable to expect an even greater preponderance of immature specimens. Hence if only a few specimens of a fossil are obtained from a given horizon under ordinary methods of collecting the probabilities are that the two opposing sets

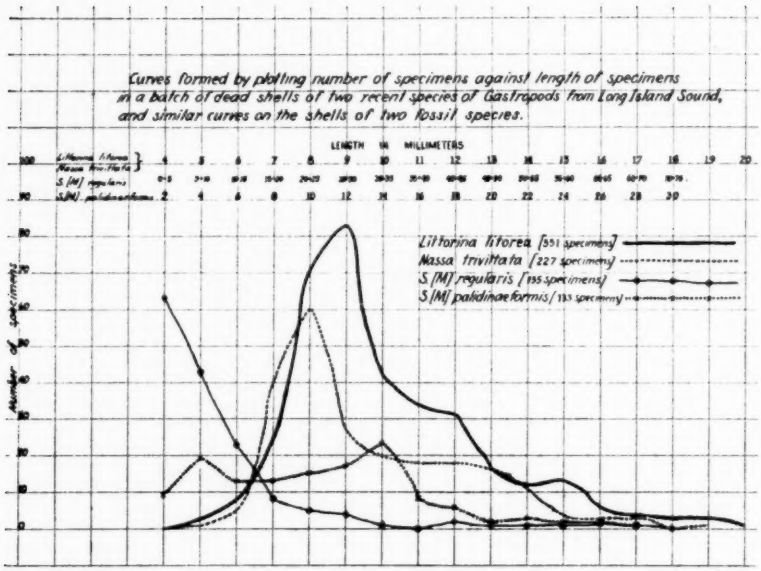

Curves formed by plotting number of specimens against length of specimens in a batch of dead shells of two recent species of Gastropods from Long Island Sound, and similar curves on the shells of two fossil species.
LENGTH IN MILLIMETERS
Number of specimens
Littorina littorea (551 specimens)
Nassa trivittata (227 specimens)
S.[M.] regularis (195 specimens)
S.[M.] paldinaeformis (193 specimens)

FIG. 3—Curves formed by plotting number of specimens against length of specimens in collections of two recent and two fossil gastropod species.

of conditions, the greater abundance of small specimens and the greater conspicuousness of the large ones will tend to result in collections containing these two extremes, which may readily be mistaken for distinct species.

The bearing of this point on the problem of synonymy is obvious. The discovery of one or even many small specimens differing from other large specimens in respect to size alone or in this respect and others that might be interpretable as characters of youth, need not afford grounds for considering the small and the large specimens as belonging to different species. I do not mean to imply that size alone may not be a good specific character but that a great deal of caution should be employed in using it.

It would seem reasonable to suppose that specimens of a small species should be small in all particulars and not compare whorl for whorl with the young of a larger species. A given number of whorls in a small species should produce a lesser length, for instance, than the same number in a closely related larger species, and the nucleus of the smaller species should be smaller. It should also show any sign of maturity characteristic of the group to which it belongs at a small size.

UNRECOGNIZABLE AMERICAN PENNSYLVANIAN SPECIES

The following species are wholly unrecognizable. Their descriptions are inadequate, their types are lost or destroyed and they were not figured by their authors. Such of them as have been considered by later authors are in no case based on topotype material and are almost certainly misidentifications referable to other species.

Soleniscus (*Macrochilina*) *danvillensis* (Stevens) described as *Loxonema*.
S. (*M.*) *politus* (Stevens) described as *Loxonema*.
S. (*M.*) *kansasensis* (Swallow) described as *Macrocheilus*.
S. (*M.*) *missouriensis* (Swallow) described as *Macrocheilus*
S. (*M.*) *ponderosus* (Swallow) described as *Macrocheilus*.
S. (*M.*) *texanus* (Shumard) described as *Macrocheilus*.

The following are illustrated by their authors, but so poorly that they seem to be entirely unrecognizable.

S. (*M.*) *inhabilis* (Morton) described as *Fusus* (?).
S. (*M.*) *hildrethi* (Conrad) described as *Plectostylus*.
S. (*M.*) *gracilis* (Cox) described as *Macrocheilus*.
S. (*M.*) *hallanus* (Geinitz) described as *Macrocheilus*.
S. (*M.*) *humilis* (Keyes) described as *Macrocheilus*.

Both of these last two species are described and illustrated from what appear to be juvenile specimens of some form or forms close to *S.* (*M.*) *regularis* (Cox) and yet it is impossible on the basis of the descriptions and figures either to assign them to synonymy or to hold them distinct. Both were derived from identifiable horizons at definite localities and it may be possible to recognize them eventually by the aid of topotypes, but at present they cannot be distinguished.

RECOGNIZABLE AMERICAN PENNSYLVANIAN SPECIES

The species next discussed seem to be valid, recognizable either from their original descriptions and figures or from their types some of which I have been privileged to examine and refigure in this paper. Under each name synonyms are cited only so far as to include the first application of a name. Subsequent identifications or misidentifications will only be noticed in the fuller synonymies under the description of species.

The last five species and their synonymies are considered in detail in the descriptive part of this paper.

S. (*M.*) *altonensis* (Worthen). The holotype is refigured on Plate 26, figure 1. I cannot agree with Girty that this species is the same as *S.* (*M.*) *intercalaris* (Meek and Worthen). I have seen the holotype of each and they seem quite distinct in certain apertural characters.

S. (*M.*) *brevis* (White). I cannot agree with White that this species is a synonym of *S.* (*M.*) *ventricosus* (Hall). White's descriptions and figures certainly apply to a

different form than that represented by Hall's holotype. *S.* (*M.*) *brevis* is considered more in detail in the descriptive part of this paper.

S. (*M.*) *intercalaris* (Meek and Worthen). The holotype is refigured on Plate 26, figure 2; synonym, *S.* (*M.*) *pulchellus* Meek and Worthen.

S. (*M.*) *klipparti* (Meek). This is a species somewhat similar to *S.* (*M.*) *regularis* (Cox) but its spire has a different shape. It seems quite distinct.

S. (*M.*) *medialis* (Meek and Worthen).

S. (*M.*) *paludinaeformis* (Hall), (see pl. 23, fig. 2i); synonym, *S.* (*M.*) *ventricosus* (Hall), (see pl. 23, fig. 2g).

S. (*M.*) *primigenius* (Conrad).

S. (*M.*) *regularis* (Cox), synonyms *S.* (*M.*) *newberryi* (Stevens), (see pl. 24, fig. 2d), *S.* (*M.*) *carinata* (Stevens), *S.* (*M.*) *fusiformis* (Hall), (see pl. 24, fig. 2h), *S.* (*M.*) *inornata* (Meek and Worthen), (see pl. 24, fig. 2a), *S.* (*M.*) *chrysolis* (Meek and Worthen), *S.* (*M.*) *planus* (White).

S. (*Soleniscus*) *typicus* Meek and Worthen, (see pl. 22, fig. 1f), synonym, *S.* (*S.*) *nitidula* (Meek and Worthen), (see pl. 22, fig. 1h).

In addition to the above mentioned eight species of *Soleniscus* (subgenus *Macrochilina*) and one of *Soleniscus* (ss) there are described for the first time in this paper one species of the subgenus *Macrochilina* and one of the subgenus *Cylindritopsis*, bringing the recognizable American Pennsylvanian species of the genus to eleven. There are also described here three species of the genus *Auriptygma* and two of the new genus, *Ceraunocochlis*.

PENNSYLVANIAN SPECIES AND GENERA EXCLUDED FROM THE SUBULITIDAE

It will be well to state clearly that certain species and genera of the Pennsylvanian, commonly associated with this group, seem to have nothing in common with it except a superficial resemblance. The genus *Meekospira*, for instance, though resembling the Subulitidae superficially, has entirely different apertural characters. The little shell described and figured by Meek and Worthen under the name *Acteonina minuta* (Stevens) and commonly referred to *Bulimorpha* also has very different apertural characters. The apertural characters of the form described by White as *Macrocheilus anguliferus* are not adequately known, but they seem to be similar to those of the last mentioned form. The small species *Macrocheilus ? micula* Girty seems also to be removed from the Soleniscinae It is planned to treat these and some other forms in a subsequent paper.

STRATIGRAPHIC SECTION, LOCALITIES, AND ACKNOWLEDGMENTS

This is the third of a series of papers dealing with the gastropods of the St. Louis, Pennsylvanian outlier. For the stratigraphic section and some other matters of detail the reader is referred to the first paper of the series (30).

There would be little purpose in repeating here the acknowledgments made in the first of the series. My indebtedness to those the assistance of whom is there acknowledged has been greatly increased. I must, however, not fail to mention two additional names. Professor T. E. Savage of the University of Illinois has been kind enough to lend me the types of a number of Meek and Worthen's species through Dr. J. M. Weller of the Illinois State Geological Survey. Dr. Chester A. Reeds of the American Museum of Natural History in New York has also been kind enough to lend the types of some of Hall's species. Without these types my efforts to deal with some of the difficult species of this group would have been in vain. Photographs of some of these types are reproduced here for the first time.

Inasmuch as some of the specimens discussed were derived from several collecting localities not previously mentioned, a register of localities is included. It unavoidably contains some repetition from the first paper of the series.

The specimens from my own collections figured here are deposited in the Peabody Museum of Natural History, of Yale University. Unfigured types may also be seen at the United States National Museum at Washington, at Washington University in St. Louis and at the Musée Royale d'Histoire Naturelle at Bruxelles, Belgium. Dr. George H. Girty of the United States Geological Survey has also made collections at some of my localities, so that representatives of most of the species in my collections should also be in the possession of the Survey at Washington.

FOREWORD TO THE DESCRIPTION OF SPECIES

It will be noted that some citations appearing in the synonymies of other workers here receive no mention. It has been my endeavor to construct my synonymies on the principle that the listing of a name constitutes my endorsement of the identification or in some cases my dissent from the identification previously made. Thus, since they are accompanied by none of the evidence on which identifications were made, citations from faunal lists are omitted. Also certain commonly cited works, though more pretentious in form, are merely annotated faunal lists and offer no evidence whatever as vouchers for the identifications made, or if they do in a few instances supply illustrations, these are copies of previously published illustrations. Many of the citations from Keyes' works ordinarily appearing in synonymies are of this class. Identifications, at least so far as the species of this group are concerned, are unaccompanied by descriptions and his figures are so poor as to be

absolutely uninterpretable. In such instances I am unable to confirm or deny the author's identifications and hence do not cite them.

The descriptions in this paper have been drawn much as in the previous papers of the series. However, it was found that certain measurements of significance in other groups were without significance or impossible to make accurately in this one. "Apical angle" is an example. Again others not applicable in the other groups were found to be significant in this. Such hardly need explanation.

Natural size illustrations of nearly all the specimens figured at greater than natural size accompany the enlarged illustrations. It is thought that these aid the student to visualize more easily the actual size of a specimen in comparison with other specimens illustrated for one reason or another on a different scale.

The study of columellar thin-sections of the species here discussed has proven profitable and it seems quite probable that species can be recognized in thin-section. Though no attempt has been made to describe the specific characters shown in the sections separately from those to be seen outwardly, it is thought that photographs of the thin-sections are worthy of illustration. They will be found assembled on Plate 27.

KEY TO THE GENERA AND SUBGENERA OF THE SUBULITIDAE KNOWN TO OCCUR IN THE CARBONIFEROUS

A¹ Shells of moderate size; nucleus smooth, turbinate; aperture suboval to sub-elliptical.

B¹ Form robust; inductura thin on the parietal wall; single fold on the columella low and obscure ..... AURIPTYGMA

B² Form robust or slender; moderately to strongly developed siphonal fold ..... SOLENISCUS (SENSU LATO)

C¹ Siphonal channel relatively broad; siphonal fold strong within the aperture; posterior fold rudimentary; the inductura moderately to strongly thickened MACROCHILINA

C² Siphonal and posterior folds both strongly developed, the latter on the parietal wall; inductura thickened .. CYLINDRITOPSIS

C³ Siphonal fold low, channel narrow, notch narrow and placed far forward

D¹ No posterior fold, columella arcuate ..... BULIMORPHA

D² Strongly developed posterior fold close behind siphonal fold, columella straight ..... SOLENISCUS (SENSU STRICTO)

A² Shells very small; nucleus smooth, flat on top; anterior margin of aperture effuse, flaring ..... CERAUNOCOCHLIS

FAMILY SUBULITIDAE LINDSTRÖM

SUBFAMILY SUBULITINAE KNIGHT, N. SUBFAM.

GENUS CERAUNOCOCHLIS KNIGHT, N. GEN.

CERAUNOCOCHLIS FULMINULA KNIGHT, N. SP.

Plate 21, figure 1a-d, Plate 27, figure 1

	A	B
Number of whorls	9	8
Height	4.35 mm.	3.83 mm.
Width	1.10 mm.	.93 mm.
Ratio of height to width	3.95	4.13
Ratio of height of body whorl to total	.50	.52
Pleural angle	15°[a]	17°[a]

A. The holotype (pl. 21, figs. 1a-b), the largest specimen.
B. A paratype (pl. 21, figs. 1c-d).

[a]Owing to the peculiar shape of this species, it is impossible to measure this angle in the usual way or with any accuracy.

Very small; roughly cigar-shaped; side away from aperture gently convex, the apertural side nearly straight, whorl profile flat; sutures exceedingly obscure at ephebic stages, slightly impressed at neanic stages; inductura thin; siphonal notch distinct; aperture flaring below somewhat similar to that of *Subulites;* surface smooth and without ornamentation, nucleus somewhat darker than rest of shell but no other traces of coloration observed.

It is a relatively simple matter to describe this remarkable little shell so that it may be recognized, in fact its resemblance to a tiny *Subulites* seems to set it off from anything with which I am acquainted and yet to describe it in all of its peculiar details is more difficult. It is hoped that the illustrations will in this instance as in many others do far more to make clear its character to the student than can be done with words.

I have 21 specimens from the top of the Labette shale at Locality 43, three from Zone R and 18 from Zone G. Holotype, Yale Peabody Museum, No. 13163.

CERAUNOCOCHLIS BLATTA KNIGHT, N. SP.

Plate 21, figures 2 a-d

	A	B
Number of whorls	4	4
Height	1.7 mm.	1.71 mm.
Width	1.1 mm.	1.05 mm
Ratio of height to wdth	1.54	1.66
Ratio of height of body whorl to total	.91	.94
Pleural angle	73°	72°

A. The holotype (pl. 21, figs. 2 a-b).
B. A paratype (pl. 21, figs. 2 c-d).

Extremely small, with few whorls; sub-oval, the shape suggesting a small moth with an injured wing; spire very short, mammillary; sutures indistinct; inductura very slightly thickened; siphonal notch rather conspicuous; siphonal fold well defined and at a low angle to axis of shell; outer lip flaring; surface smooth, unornamented; color in life unknown, though the last shell matter added to the outer lip of the holotype is of a lighter gray than the rest of the shell and its inductura preserves traces of black pigment.

This tiny species is as far as I know unique. I have considered the possibility that the specimens included might be the young of some larger species but find nothing to sustain such a supposition. They are definitely not referable to *Soleniscus*. The coiling of the earlier whorls alone would exclude them.

I have four specimens, all from Zone R at the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 13164.

SUBFAMILY SOLENISCINAE KNIGHT, N. SUBFAM.

GENUS SOLENISCUS MEEK AND WORTHEN, EMEND. KNIGHT

SUBGENUS SOLENISCUS MEEK AND WORTHEN, EMEND. KNIGHT

SOLENISCUS (SOLENISCUS) TYPICUS MEEK AND WORTHEN

Plate 22, figures 1 a-k, Plate 27, figure 8

Soleniscus typicus MEEK AND WORTHEN, *1860*, Phila. Acad. Nat. Sci., Proc., p. 467; *1866*, Ill. Geol. Survey, vol. 2, p. 384, pl. 31, figs. 15 a, b, Pennsylvanian, Springfield, Illinois; WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 18, 19,

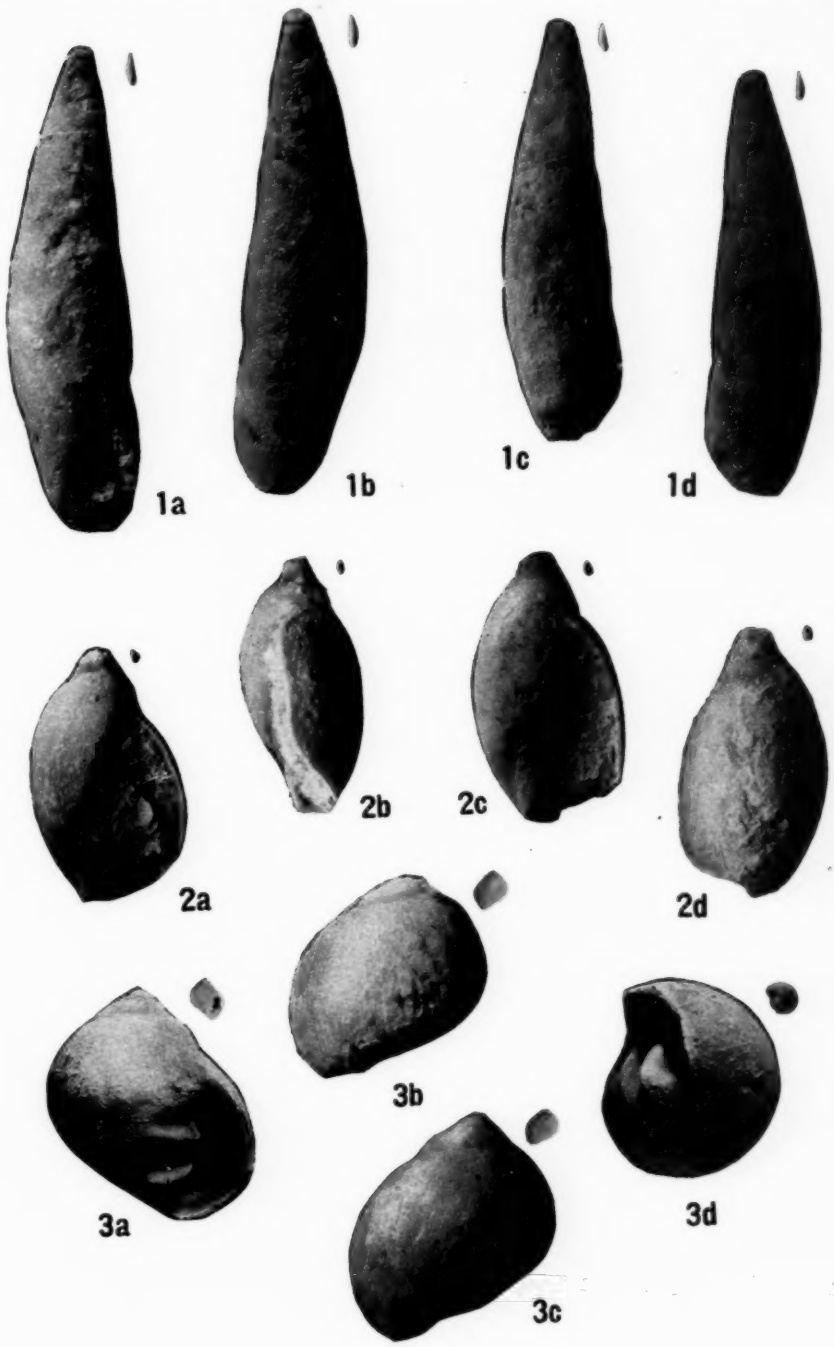
---

EXPLANATION OF PLATE 21

FIGS. 1—*Ceraunocochlis fulminula* Knight, n. sp. All figures × 15. All specimens are from the St. Louis outlier. *a*, The holotype, apertural view. *b*, The holotype, dorsal view. *c*, A paratype, apertural view. *d*, Dorsal view of the same paratype. Note the flat-topped protoconch followed by a rather deep suture. The sutures at post-nuclear stages are extremely obscure.

2 *a-d*—*Ceraunocochlis blatta* Knight, n. sp. All figures × 20. All specimens are from the St. Louis outlier. *a*, The holotype, apertural view. *b*, The holotype, side view showing shape of outer lip and lighter color of last growth increment. The outer lip and the anterior margin of this specimen are unbroken. *c*, A paratype, apertural view. Anterior margin slightly broken. *d*, Dorsal view of the last mentioned specimen.

3 *a-d*—*Soleniscus* (*Cylindritopsis*) *vaningeni* Knight, n. sp. All figures × 6. All specimens are from the St. Louis outlier. *a*, The holotype, apertural view. Note the two massive, columellar folds and the shelf-like thickening within the outer lip. *b*, Dorsal view of the holotype. *c*, Dorsal view of a paratype. *d*, Basal view of the holotype. The basal margiu of the outer lip is very slightly broken away. When it is unbroken, the notch is even more clearly marked.



Knight, Pennsylvanian Gastropods

Pennsylvanian, Springfield, Illinois; MARK, *1912*, Ohio Geol. Survey, 4th ser., Bull. 17, p. 317, pl. 16, fig. 16, Ames limestone, Conemaugh formation, Pennsylvanian, New Concord, Ohio.

Loxonema nitidula MEEK AND WORTHEN. *1860*, Phila. Acad. Nat. Sci., Proc., p. 465. Pennsylvanian, Springfield, Illinois.

Polyphemopsis nitidula (Meek and Worthen), MEEK AND WORTHEN, *1866*, Ill. Geol. Survey, vol. 2, p. 374, pl. 31, figs. 9 a, b. Pennsylvanian, Springfield, Illinois.

	A	B	C
Number of whorls	11[a]	8[d]	9[d]
Height	32 mm.[a,b]	11.6 mm.[d]	15.5 mm.[d,e]
Width	11 mm.[c]	4.3 mm.	6.7 mm.
Ratio of height to width	2.65	2.68	2.3
Ratio of height of body whorl to total	.60	.66	.69
Pleural angle	29°	32°	46°
Angle made by siphonal fold with columella	16°	?	11°
Angle made by posterior columellar fold with columella	46°	?	50°

A. The cyrioplesiotype (pl. 22, fig. 1 j). An apparently mature example.
B. A plesiotype (specimen not figured).
C. A plesiotype (pl. 22, fig. 1 c). A specimen with rather wide pleural angle.

[a]Estimated on the assumption that 2 apical whorls are missing.
[b]Allowing about 2½ mm. for restoration of anterior margin.
[c]Allowing about 1 mm. for restoration of lost whorl.
[d]Estimated on the assumption that 1 apical whorl is missing.
[e]Allowing about 2 mm. for restoration of anterior margin.

Of moderate size; slender, high-spired and with anterior portion of the body whorl rather slender and drawn out; sides of spire straight or very gently convex; whorl profile very gently arched; sutures very slightly impressed; inductura thin; siphonal fold low, rounded, inconspicuous, making a very low angle with the columella, bordered anteriorly by narrow and deep siphonal channel and posteriorly by a groove of similar dimensions lying between the siphonal fold and the posterior fold, posterior fold high, thin, conspicuous, ending gradually just within the aperture and scarcely visible unless some of the outer lip is broken away; surface smooth, almost polished; growth lines indistinct; color in life a uniform dark gray, almost black.

In this species there is an amazing difference in the appearance of entire specimens and those with the outer lip broken away. Indeed it is not surprising that Meek, lacking a sufficient suite of specimens in all stages of breakage and not recognizing that his holotype was a broken specimen, placed the broken and the entire specimens in different genera, or that later authors, basing their concepts on Meek's work and not on actual specimens at all, have continued to do so.

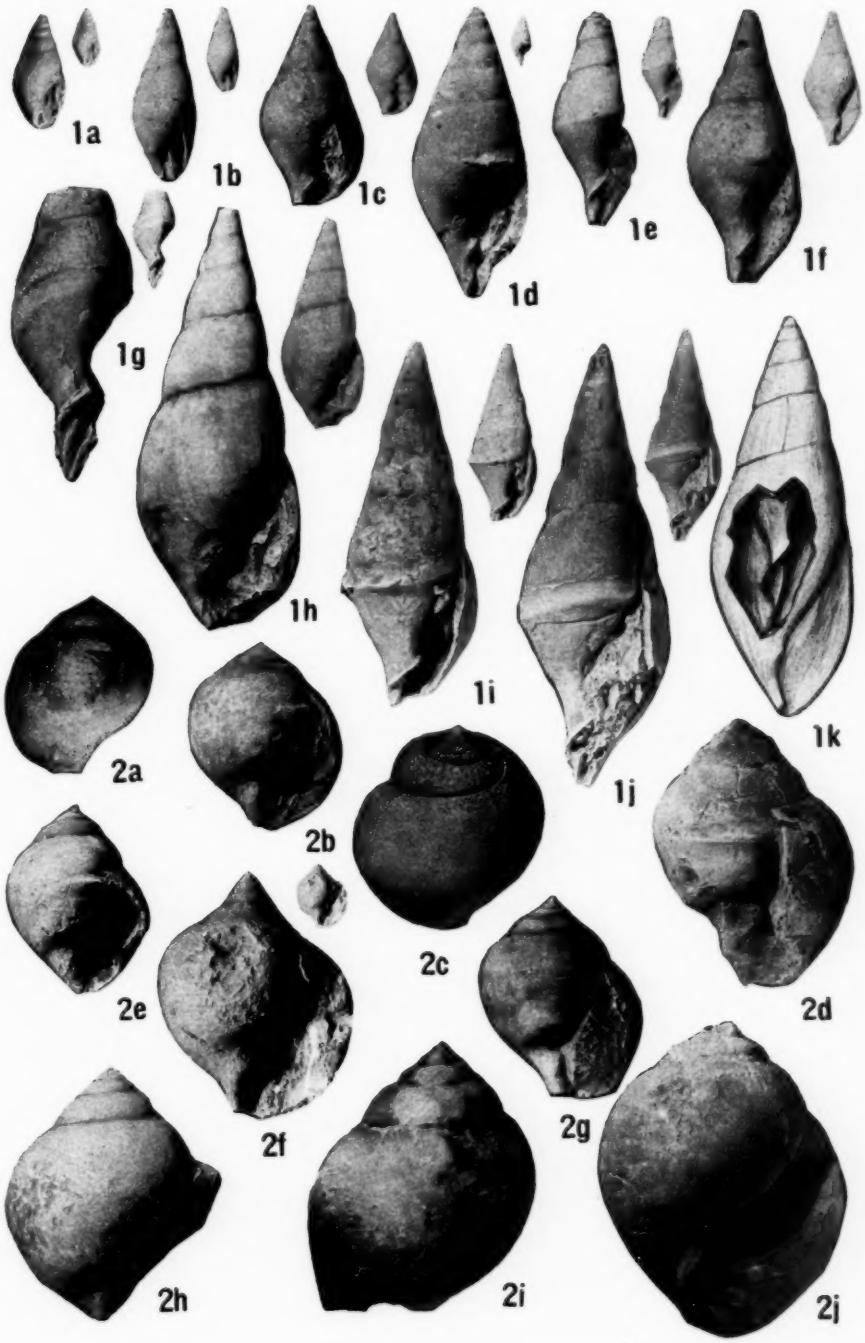
In broken specimens the posterior columellar fold is very conspicuous while the anterior or siphonal fold is inconspicuous and, lying as it does at only a small angle to the axis of the shell, seems to form the inner lip

of a produced canal. With entire specimens on the other hand, and especially with such specimens which have the aperture filled with matrix, the posterior fold can be seen only as an inconspicuous, local thickening of the inductura of the columellar lip or is entirely invisible. In this

EXPLANATION OF PLATE 22

FIGS. 1 *a-k*—*Soleniscus* (*Soleniscus*) *typicus* Meek and Worthen. All specimens from the St. Louis outlier except *e*, *f* and *h*, which are in the Worthen collection at the University of Illinois. *a*, A somewhat robust juvenile. The outer lip is broken away for about ¼ whorl, (× 2). *b*, A slender specimen about 1-3 grown. The outer lip is nearly all preserved though somewhat broken, (× 2). *c*, A robust specimen, about ½ grown. The outer lip is broken away for about ¼ whorl, (× 2). *d*, A slender juvenile with the outer lip broken away for about ¼ whorl, (× 6). *e*, Meek and Worthen's paratype. The outer lip is broken away for about 1-3 whorl, (× 2). *f*, Meek and Worthen's holotype, their figured specimen. The outer lip is broken away for about ¼ whorl, (× 2). *g*, A specimen with the outer lip broken back for about 1¼ whorls and tilted slightly backward to show clearly the two columellar folds, (× 3). *h*, A large specimen with unbroken outer lip and apertural characters partly obscured by matrix. The anterior margin is slightly broken, (× 2). This is Meek and Worthen's holotype of *Loxonema nitidula* M. and W. here referred to synonymy. *i*, A nearly grown specimen with outer lip broken away about ¼ whorl, (× 2). *j*, The cyrioplesiotype, a fully grown (?) specimen with outer lip broken away for about 2-3 whorl, (× 2). *k*, A drawing to illustrate the relations of the siphonal and posterior folds to apertural characters seen on unbroken shells. The external characters were taken from the specimen figured as 1*b* on this plate and hence represent an individual about 1-3 grown, (approximately × 4). The internal characters were drawn after the consideration of a large suite of specimens in all stages of breakage.

2 *a-j*—*Soleniscus* (*Macrochilina*) *primigenius* (Conrad). All specimens from the St. Louis outlier except *g*, and *j*. The former is in the Worthen collection at the University of Illinois and the latter in the Hall collection at the American Museum of Natural History. *a* and *b*, Dorsal and apertural views respectively of a ½ grown individual of the more robust type. Outer lip broken away for about ¼ whorl, (× 1). *c*, A robust specimen of abnormal coiling, slightly tilted toward the observer, (× 1). *d*, A large specimen of the more slender type with the outer lip broken away about 1-3 whorl, (× 1). This specimen illustrates well the siphonal fold and the low and obscure posterior (upper) fold. *e*, A half grown specimen of more slender form, (× 1). Outer lip broken away for about 1-5 whorl. *f*, A juvenile specimen, (× 4). Outer lip broken away for about 1-8 whorl. This specimen illustrates the concave sides and sharp apex of this species at its early development stages. *g*, A half grown moderately robust specimen. This specimen is in the Worthen collection at the University of Illinois and is labelled as the type of *Macrocheilus medialis* Meek and Worthen, (× 1). As it agrees neither with the description nor figure given by Meek and Worthen, it is obviously mis-labelled. *h*, The cyrioplesiotype, (× 1). Very little of the outer lip of this species is lost, yet it is mashed close into the side. *i*, A rather large, moderately robust specimen, (× 1). *j*, Hall's cyrioplesiotype, (× 1). The specimen is somewhat mashed in the plane of the picture.



Knight, Pennsylvanian Gastropods

condition the siphonal fold is not seen as a fold but as the inner lip of the small siphonal notch. The drawing on Plate 22, figure 1k, a composite worked out from a number of specimens, is intended to show these relationships.

There cannot be the slightest doubt that my specimens are correctly referred to *Soleniscus typicus* Meek and Worthen. I have had the privilege of examining the holotype and a paratype. The former is shown on Plate 22, figure 1f. My specimens, however, include some that are larger and more mature, some much smaller, some with wider and some with narrower pleural angles.

There can be little question also that Meek and Worthen's *Loxonema*, or *Polyphemopsis*, or as placed by later authors *Bulimorpha nitidula*, the type of which is from the same horizon and locality as those of *S. (S.) typicus*, and which type I have seen (see pl. 22, fig. 1h) belongs to the same species. It is merely a larger example with only a very little of its anterior margin removed.

White's citation of *S. (S.) typicus* was based on an "authentic duplicate example" loaned him by Worthen, perhaps the paratype that still accompanies the holotype, though his figures are obviously copies of Meek and Worthen's. His citation of *Polyphemopsis nitidula* (35, p. 370, pl. 48, figs. 7, 8) I cannot endorse. His figure, an original one, seems to show a *Meekospira*, possibly *M. choctawensis* Girty.

Mark's citation of *S. (S.) typicus* is difficult to evaluate, but her figure, an original one, seems to show a specimen that is probably correctly identified. Keyes' various citations of both names seem to be based on the literature and not on actual specimens. Hence I omit them, as they can not be authenticated from any evidence given by him.

I have 65 specimens, all from the top of the Labette shale. One is from Locality 6 and the rest from Locality 43. Of the latter, 29 are known to have come from Zone G and 5 from Zone R, leaving 30 specimens unplaced as to these zones. The specimens from Zone R all tend toward slightly greater pleural angles than the average. Cyrioplesiotype, Yale Peabody Museum, No. 13159.

Subgenus MACROCHILINA Bayle, emend. Knight

SOLENISCUS (MACROCHILINA) PRIMIGENIUS (Conrad)

Plate 22, figures 2 a-j, Plate 27, figure 5

Stylifer primogenia Conrad, *1835*, Geol. Soc. Pa., Trans., vol. 1, pt. 2, p. 267, pl. 12, fig. 2. Brush Creek ls., Conemaugh formation, Pennsylvanian: Pennsylvania.

?*Macrocheilus inhabilis* (Morton), Norwood and Pratten, *1855*, Jour. Phila. Acad. Nat. Sci., (2), vol. 3, p. 76, pl. 9, figs. 9 a-b. Pennsylvanian, Grayville and Galatin, Illinois; Posey County, Indiana. The figured specimen apparently from Forest City, Missouri.

Macrocheilus primogenius (Conrad) HALL, *1858*, Iowa Geol. Survey, Rept., vol. 1, pt. 2, p. 270, pl. 29, fig. 11. Pennsylvanian: Indiana, Illinois and Iowa. The figured specimen from Grayville, Illinois. HEILPRIN, *1886*, Pennsylvania (2nd) Geol. Survey, Ann. Rept. for 1885, p. 446, fig. 16, p. 457, fig. 16a; Wyoming Hist. & Geol. Soc. Proc., & Coll., vol. 2, pt. 2, p. 274, fig. 16; p. 276, fig. 16a. Mill Creek limestone, Upper Coal Measures: Wilkes-Barre, Pennsylvania.

?*Soleniscus?* (*Macrocheilus*) *medialis* (Meek and Worthen), WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 15, 16; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 156, pl. 34, figs. 15, 16. Pennsylvanian, Vermillion County, Indiana.

Soleniscus (*Macrocheilus*) *texanus* (Shumard), WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 13, 14; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 155, pl. 34, figs. 13, 14. Pennsylvanian, Danville, Illinois.

Soleniscus? (*Macrocheilus*) *primogenius* (Conrad), WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, fig. 3; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 157, pl. 34, fig. 3. Pennsylvanian, Ohio, Indiana, Illinois, Iowa.

Soleniscus? (*Macrocheilus*) *ponderosus* (Swallow), WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 1, 2; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 156, pl. 34, figs. 1, 2. Pennsylvanian, Iowa.

Soleniscus (*Macrocheilus*) *ventricosus* (Hall), WHITE, *1884*, in part, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, fig. 11; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 155, pl. 34, fig. 11. Upper Pennsylvanian, Illinois.

Sphaerodoma primigenia (Conrad), GIRTY, *1915*, U. S. Geol. Survey, Bull. 544, p. 208, pl. 24, figs. 14, 15, 16, 16a, 17, 17a. Wewoka formation, Pennsylvanian, Oklahoma. PLUMMER AND MOORE, *1921*, in part, Univ. of Texas Bull. 2132, pl. 22, figs. 1, 2. MORGAN, *1924*, (Okla). Bur. of Geol. Bull. 2, pl. 1, fig. 9. Belle City formation, Pennsylvanian, Oklahoma.

Sphaerodoma brevis (White), GIRTY, *1915*, in part, U. S. Geol. Survey, Bull. 544, p. 201, pl. 24, figs. 9, 9a, 10, 10a, 11, 11a, 12, 12a. Wewoka formation, Pennsylvanian, Oklahoma.

Sphaerodoma ponderosa (Swallow), MORGAN, *1924*, (Okla.) Bur. of Geol., Bull. 2, pl. 1, fig. 8. Belle City formation, Pennsylvanian, Oklahoma.

	A	B	C
Number of whorls	9[a]	7[a]	8[a]
Height	36 mm.[a,b]	24 mm.[a,d]	25½ mm.[a,d]
Width	31 mm.[c]	19.5 mm.	19 mm.
Ratio of height to width	1.16	1.22	1.34
Ratio of height of body whorl to total	.80	.85	.80
Pleural angle	85°	98°	77°
Angle made by siphonal fold with columella	41°	40°	40°

A The cyrioplesiotype (pl. 22, fig. 2 h). A moderately large specimen of intermediate pleural angle.

B. An immature plesiotype (pl. 22, figs. 2 a-b). A rather robust specimen of high pleural angle.

C. An immature plesiotype (pl. 22, fig. 2 e). A specimen of relatively low pleural angle.

[a]Estimated on the assumption that 2 apical whorls are missing.

[b]Allowing about 2.5 mm. for lost apex and anterior margin.

[c]This measurement includes an allowance of about 3 mm. for restoring the outer lip.

[d]Allowing about 1.5 mm. for lost apex and anterior margin.

Relatively large; robust; broadly sub-oval; spire one-fifth to one-fourth the total height, sides of spire concave at neanic stages, slightly convex at ephebic stages; whorl profile gently and regularly arched;

sutures but slightly impressed; body whorl large; inductura only moderately thickened; siphonal fold low, rounded but distinct, bordered posteriorly by a wide, shallow depression; siphonal channel wide and shallow; surface smooth, almost polished; growth lines generally lacking; color in life a uniform dark gray, nearly black.

This large robust species, one of the commonest in collections of Pennsylvanian gastropods, should be relatively easy to recognize. Its distinctive characters are its broadly suboval form and its relatively low, rounded but distinct siphonal fold. These characters can be seen not only from the exterior but in thin sections as well (see pl. 27, fig. 5). Young specimens may be distinguished from *S.* (*M.*) *brevis* by their generally more robust form and by their relatively blunter and more oblique columellar fold. *S.* (*M.*) *paludinaeformis* Hall has a somewhat narrower form with more produced spire.

The relative abundance of this species in the Pennsylvanian and the frequency with which its name occurs in the literature warrants a detailed consideration of its rather extended synonymy. There can be little doubt about the identity of my specimens with Conrad's species. His figure is an excellent representation of the species if we overlook the obviously conjectural and quite impossible inner lip. Were there any other large, robust species with this general outline known in the American Pennsylvanian there might be some risk in using Conrad's name, but, since as far as I have been able to learn there is not, I feel that the identification is reasonably certain.

It is possible that *Fusus ? inhabilis* Morton (31, p. 150, pl. 3, fig. 14) should be included in this synonymy as has been done by others. However, Morton's species is utterly unrecognizable and had best be excluded. Norwood's and Pratten's identification of Morton's species, though poorly illustrated, seems almost certainly to belong here. This conclusion is reinforced by the fact that there is in the Hall collection at the American Museum of Natural History a specimen with an old label attached to it showing it to have been acquired by Hall from Norwood and to have been identified by its former possessor as *Macrocheilus inhabilis*. This specimen has certain irregularities of coiling similar to those shown on Plate 22, figure 2c that seem to be suggested in Norwood and Pratten's poor and probably composite figure. This specimen, though it was collected at Forest City, Missouri, a locality not mentioned by Norwood and Pratten in their original description, is at least an ideotype and may be taken to represent their concept of the species

in default of a holotype. It is definitely conspecific with *S.* (*M.*) *primogenius*.

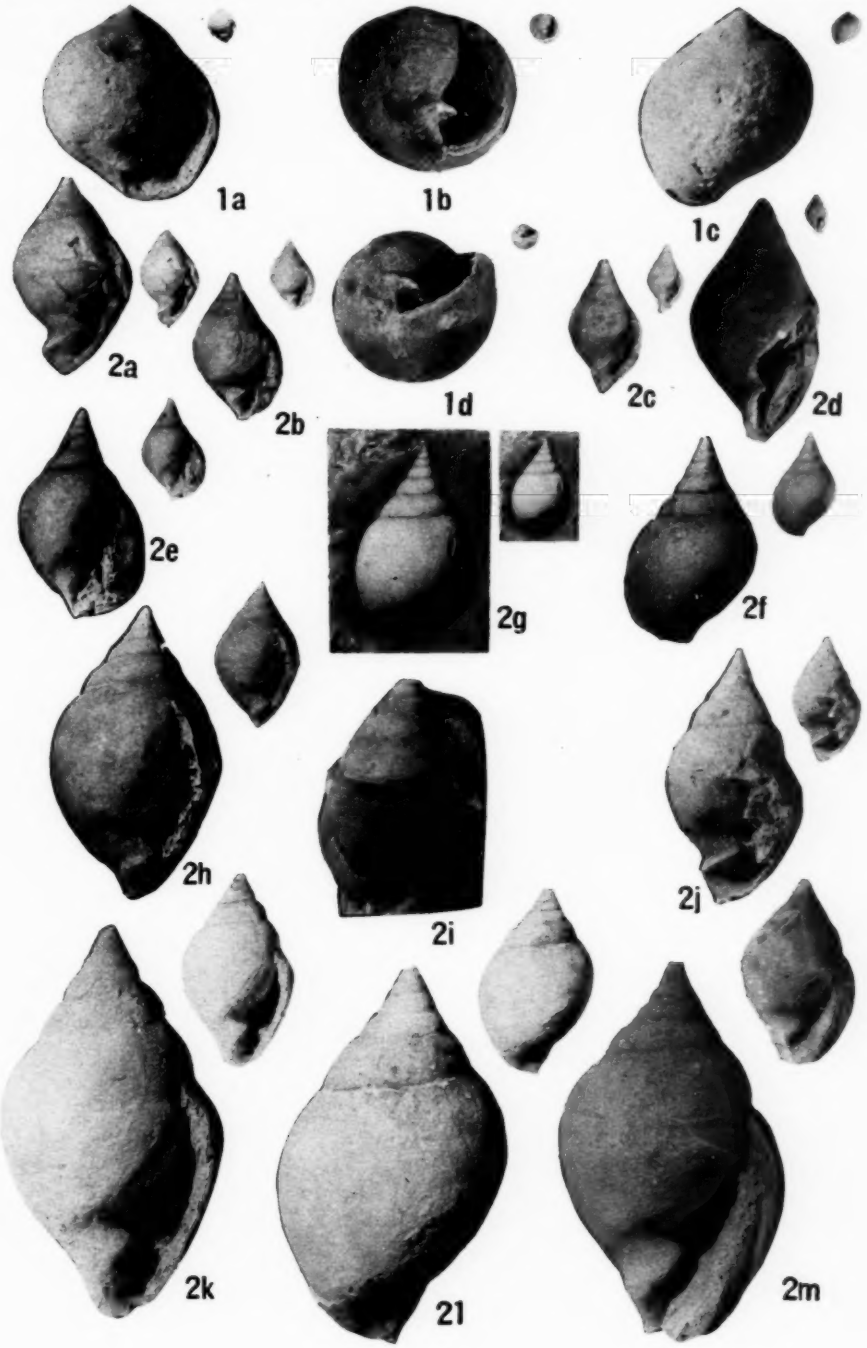
Hall's cyrioplesiotype, the specimen from which our first correct ideas of the species were drawn, I have seen and though Hall's figures are somewhat restored and the specimen as drawn appears a little more rotund that it should be through mashing and is a little distorted from the same cause, it is certainly to be included in the synonymy.

There has been some doubt in my mind as to whether *Macrocheilus medialis* Meek and Worthen should be included in the synonymy of *S.* (*M.*) *primigenius*. This doubt was based on the fact that the specimens in the Worthen collection at the University of Illinois (their No. 11008) labeled as the holotype of *M. medialis* is without question an example of *S.* (*M.*) *primigenius* though its matrix suggests that it came from the Springfield locality (pl. 22, fig. 2g). However, careful comparison of the purported type with Meek and Worthen's figures and consideration of it in the light of their description make it quite certain that the purported type is through some error not the true one. The true holotype is probably lost.

EXPLANATION OF PLATE 23

FIGS. 1 *a-d*—*Soleniscus* (*Macrochilina*) *welleri* Knight, n. sp. The holotype, (×6). Specimen from the St. Louis outlier. *a*, Apertural view. *b*, Apertural view. Shell tilted away from the observer. *c*, Dorsal view. *d*, Basal view. The lower edge of the outer lip is slightly broken away. When it is entire the notch is even more evident.

2 *a-m*—*Soleniscus* (*Macrochilina*) *paludinaeformis* Hall. All specimens from the St. Louis outlier except *g* and *i*, which are from the Hall collection at the American Museum of Natural History. *a*, A specimen about ¼ grown, (× 2). The outer lip is broken away for about ½ whorl. *b*, A specimen about 1-5 grown, (× 2). The outer lip is broken away for about 1-5 whorl. *c*, A rather slender specimen about 1-5 grown, (× 2) The outer lip is broken away for about ¼ whorl. *d*, A juvenile, (× 6) The outer lip is broken away for about ¼ whorl. Note the sharpness of the siphonal fold at the early growth stage. *e* and *f*, My cyrioplesiotype; about 1-3 grown, (× 2). Its outer lip is almost unbroken through slightly distorted. *g*, A specimen which is almost an exact duplicate of the preceding, (× 2). This is Hall's holotype of *Macrocheilus ventricosus*. Its apertural side is embedded in matrix. *h*, A half grown individual, (× 2). The outer lip is broken away for about 1-6 whorl. *i*, Hall's holotype of *Macrocheilus paludinaeformis*, (× 1). The specimen is partly exfoliated, is partly embedded in matrix and lacks the earlier whorls. It is the largest specimen I have seen. *j*, A specimen, almost half grown, with the outer lip broken away for almost ½ whorl, (× 2). *k*, A ¾ grown specimen, (× 2). Apertural view; outer lip broken away for about 1-10 whorl. *l*, and *m*, Dorsal and apertural views of a ¾ grown specimen, (× 2). Outer lip broken away for about 1-3 whorl.



Knight, Pennsylvanian Gastropods

White's identification of *Soleniscus medialis* on the other hand seems to be a slender specimen of *S.* (*M.*) *primigenius* similar to that illustrated on Plate 22, figure 2e. However, since there is some element of doubt, I precede the reference with a query.

White's identifications of *S.* (*M.*) *texanus* (Shumard), *S.* (*M.*) *ponderosus* (Swallow) and *S.* (*M.*) *primigenius* (Conrad) are all unquestionably to be referred to the last named. The second named is the largest example of the species as yet figured, but appears to differ in no other respect.

The specimen figured by Heilprin and upon which his identification was based leaves much to be desired in the way of preservation and yet it seems that, since no other large, robust species is known, it may reasonably be taken as correct, though with some slight element of doubt.

Girty's identifications of this species are all unquestionably correct, but I would also include here the last four of the five specimens he identified with *S.* (*M.*) *brevis* (White) as they do not possess the strong siphonal fold of that species but the less prominent one and the form of *S.* (*M.*) *primigenius*. They seemed to be typical young specimens of the last named as does one of the two specimens (fig. 11) figured by White under the name of *S.* (*M.*) *ventricosus* (Hall) in his U. S. National Museum and his Indiana Survey Report. The first of Girty's five specimens of *S.* (*M.*) *brevis* has a straight columella with the undeveloped fold of the subgenus *Auriptygma* and is even further removed from White's species.

The first two specimens referred to *S.* (*M.*) *primigenius* by Plummer and Moore (loc. cit. pl. 22, figs. 1 2) are unquestionable examples of the species, but the third (fig. 3) is not only too narrow but has too high a spire. Its apertural characters are not whown and I hesitate to place it specifically. It seems to approach more closely to *S.* (*M.*) *paludinaeformis* of Hall than any specimen I have seen figured.

Keyes' citations of 1889 and 1895 (3, p. 306; 32, p. 213, 215) of several of the names appearing above are without the substantiating evidence of either description or figures and no more merit citation than other fossil lists. His figures of the first mentioned year (3, pl. 20) seem to be tracings from previous figures of other authors and will receive no consideration.

Herrick figures a specimen which he refers to *Macrocheilus ponderosus* (33, pl. 11, fig. 6), but he gives no description and his figure is abominable. It is wholly unrecognizable and I do not cite it.

Morgan (loc. cit.) figures two specimens of this species. One of these a robust form he identifies correctly. The other, not quite so robust, he refers to *S.* (*M.*) *ponderosus* (Swallow).

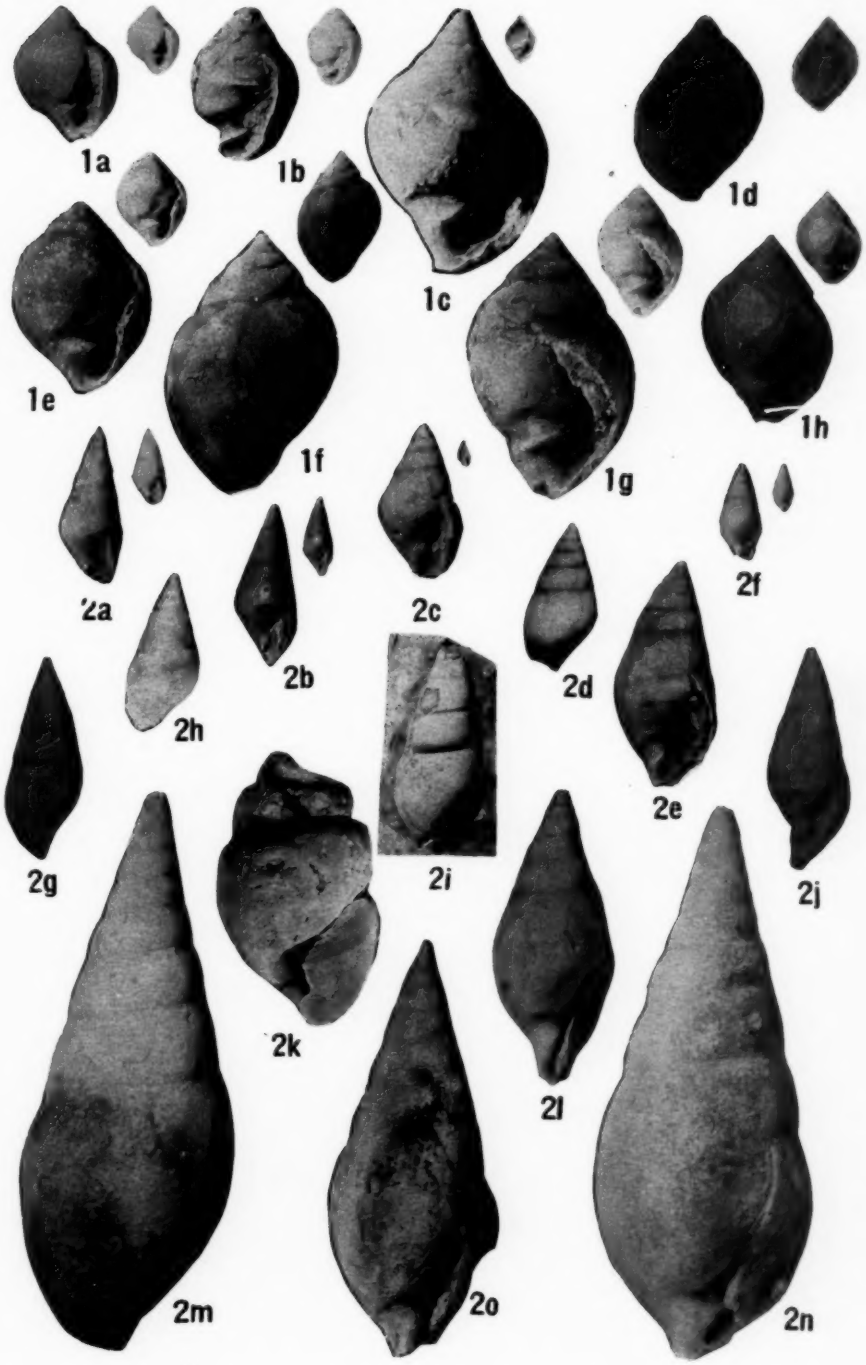
I have 37 specimens of this species, all from the top of the Labette shale at Locality 43. Twelve of these specimens are known to have been

---

EXPLANATION OF PLATE 24

FIGS. 1 *a-h*—*Soleniscus* (*Macrochilina*) *brevis* (White). All specimens from the St. Louis outlier. *a*, A 1-3 grown specimen, (× 2). Outer lip broken back for about 1-10 whorl. *b*, A ½ grown specimen, (× 2). Outer lip broken away for about ½ whorl. Note strong, sharp siphonal fold at high angle to columella, and rather narrow depression between siphonal fold and obscure posterior fold. *c*, A juvenile specimen, (× 6). Outer lip broken away for about 1-3 whorl. *d*, Dorsal view of a ¾ grown specimen, (× 2). *e*, Apertural view of ¾ grown specimen, (× 2). Outer lip broken away for about ¼ whorl. *f*, and *g*, The cyrioplesiotype, my largest specimen, (× 2). Outer lip broken away for about ¼ whorl. *h*, Apertural view of ¾ grown specimen, the same as shown as figure 1 *d*, (× 2). Outer lip broken away for only about 1-10 whorl.

2 *a-o*—*Soleniscus* (*Macrochilina*) *regularis* (Cox). All specimens from the St. Louis outlier except *a*, which is in the Worthen collection at the University of Illinois, and *d*, *e* and *h*, which are in the Hall collection at the American Museum of Natural History. *a*, A specimen about 1-8 grown, (× 2). The anterior margin is broken away. This is the holotype of *Polyphemopsis inornata* Meek and Worthen. *b*, A specimen that agrees in all respects with the last mentioned, but which forms but one complete growth series of *S.* (*M.*) *regularis*, (× 2). *c*, A juvenile specimen of rather wide pleural angle, (× 6). *d*, A ¼ grown specimen of rather wide pleural angle, (× 1). This is a metatype, perhaps a paratype of *Loxonema newberryi* Stevens and is the specimen figured by Hall. *e*, A 1-3 grown specimen, (× 1). Another metatype of *L. newberryi* Stevens. *f*, A juvenile specimen of narrow pleural angle, (× 2). *g*, A ½ grown specimen, (× 1). *h*, A ¼ grown specimen, (× 1). *i*, A specimen of rather narrow pleural angle, about 3-8 grown, (× 1). This is Hall's holotype of *Macrocheilus fusiformis*. The specimen is largely exfoliated, half buried in matrix and lacks several apical whorls. *j*, A 1-3 grown specimen with the outer lip broken away for about ¾ whorl. *k*, A steinkern of a rather large specimen referred to this species. It is lighted from below contrary to the usual convention in order to show better the cast of the siphonal channel. *l*, A half grown specimen of fairly wide pleural angle and with better preserved anterior margin than is common, (× 1). The outer lip is broken away for about ¼ whorl and is mashed in. *m*, and *n*, Dorsal and apertural views of my largest specimen, the cyrioplesiotype, (× 1). The outer lip, though, badly mashed in, lacks only about 1-8 volution. Several millimeters are missing from the base of the columella. *o*, A ¾ grown specimen of slightly greater pleural angle than the preceding, (× 1). The outer lip is very little broken at its upper end, though lower down both the outer lip and the columella have lost several millimeters by breakage.



Knight, Pennsylvanian Gastropods

derived from Zone R, and 8 from Zone G. The other 17 are unallocated as between the two zones. Cyrioplesiotype, Yale Peabody Museum, No. 13152.

SOLENISCUS (MACROCHILINA) PALUDINAEFORMIS (HALL)

Plate 23, figures 2 a-m, Plate 27, figure 6

Macrocheilus paludinaeformis HALL, *1858*, Iowa Geol. Survey, Rept., vol. 1, pt. 2, p. 719, pl. 29, fig. 10. Lower Pennsylvanian, Alpine Dam, Des Moines River, Iowa.

Macrocheilus ventricosus HALL, *1858*, loc. cit., p. 718, pl. 29, fig. 8. Lower Pennsylvanian, Alpine Dam, Des Moines River, Iowa. (Not *Phasianella ventricosa* Goldfuss, 1841, nor *Loxonema ventricosa* de Koninck, 1843, nor *Strobeus ventricosus* de Koninck, 1881, all of them here referred to the genus Soleniscus, subgenus *Macrochilina*.)

Soleniscus (*Macrocheilus*) *paludinaeformis* (Hall), WHITE, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, fig. 17, *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 154, pl. 34, fig. 17. Pennsylvanian, Vermillion County, Indiana.

Soleniscus paludinaeformis (Hall), MARK, *1912*, Ohio Geol. Survey, (4th ser.), Bull. 17, p. 317, pl. 16, fig. 17. Brush Creek, Portersville and Ames limestone, Conemaugh formation, Ohio.

Soleniscus brevis White, MARK, *1912*, loc. cit., p. 318, pl. 16, fig. 18. Portersville and Ames limestone, Conemaugh formation, Ohio.

Sphaerodoma ventricosa (Hall), GIRTY, *1915*, U. S. Geol. Survey, Bull. 544, p. 213, pl. 24, figs. 4, 4a. Wewoka formation, Oklahoma.

Sphaerodoma brevis (White), var., GIRTY, *1915*, loc cit., p. 204, pl. 24, figs. 7, 7a. Wewoka formation, Oklahoma.

Sphaerodoma brevis (White), MORNINGSTAR, *1922*, Ohio Geol. Survey (4th ser.),Bull. 25, p. 261, pl. 15, figs. 22-24. Lower and upper Mercer, and McArthur limestone, Pottsville formation, Ohio. MORGAN, *1924*, (Okla.) Bur. of Geol., Bull. 2, pl. 1, figs. 5, 5a. Wetumka and Boggy formations, Pennsylvanian, Oklahoma.

Sphaerodoma gracilis (Cox), MORGAN, *1924*, loc. cit., pl. 1, fig. 6. Boggy formation, Pennsylvanian, Oklahoma.

Sphaerodoma intercalaris (Meek and Worthen), MORGAN, *1924*, loc. cit., pl. 1, fig. 7, Belle City formation, Pennsylvanian, Oklahoma.

	A	B	C	D	E
Number of whorls	8	20[b]	10[a]	9[a]	8[a]
Height	13.3 mm.	28 mm.[a,c]	16 mm.[a]	18 mm.[c]	13.3mm.[a,c]
Width	8.5 mm.	15.7 mm.	15.7 mm.	10.5 mm.	8.1 mm.
Ratio of height to width	1.56	1.78	1.65	1.61	1.63
Ratio of height of body whor to total	.73	.78	.73	.70	.79
Pleural angle	70°	64°	69°	75°	68°
Angle made by siphonal fold with columella	52°	56°	58°	61°	58°

A. The cyrioplesiotype (pl. 23, figs. 2e, 2g). A half-grown individual.
B. A plesiotype (pl. 23, figs. 2 k). A mature individual.
C. A plesiotype (pl. 23, figs. 2 l, 2 m). A mature individual.
D. A plesiotype. A three-quarters grown individual (not figured).
E. A plesiotype (pl. 23, fig. 2 a). A half-grown individual.

[a]Estimated on the assumption that two apical whorls are missing.
[b]Estimated on the assumption that three apical whorls are missing.
[c]Allowing about 1 mm. for restoring anterior margin.

Of moderate size; pear-shaped with moderately large body-whorl and tapering spire; sides of spire concave at neanic stages, convex at ephebic; whorl profile gently and evenly arched; sutures but slightly impressed; inductura only moderately thickened; siphonal fold prominent and in some specimens sharp with undercut anterior face, bordered posteriorly by moderately narrow and deep depressions, siphonal channel moderately wide, well defined; surface smooth, almost polished; growth-lines faint; color in life a uniform dark gray, nearly black

This species has been compared with *S.* (*M.*) *brevis* (White) with which it has much in common. However, that species has a less extended spire and a sharper siphonal fold which makes a much higher angle with the columella than does that of *S.* (*M.*) *paludinaeformis.*

It was only after considerable study and some hesitation that it was finally determined to place *S.* (*M.*) *ventricosus* (Hall) in the synonymy of *S.* (*M.*) *paludinaeformis* of the same author. I have had the privilege of examining Hall's holotypes of both species and a paratype of the latter. The holotype of the latter is not nearly so well preserved as Hall's figures would lead one to believe and the paratype is not much better. The types of both species are from the same horizon and locality and, judging from their matrix and preservation, from the same bed. They show much the same general conformation and differ principally in size.

Taking these facts into consideration and the fact that the many specimens of this same conformation in my own collections range without break from much smaller than the holotype of *S.* (*M.*) *ventricosus* to nearly as large as that of *S.* (*M.*) *paludinaeformis*, I have been forced to conclude that this holotype is merely a young specimen of the latter.

While it is true that the holotype of *S.* (*M.*) *paludinaeformis* has a somewhat smaller pleural angle and a seemingly more extended spire than my larger specimens, the paratype varies to the other extreme. I would have preferred to have used the name *ventricosus* as it has page precedence and the holotype represented by that name is well preserved, but it seems reasonably certain that *Phasianella ventricosa* Goldfuss is referable to *Soleniscus* and even to *Macrochilina* so that it is not available.

The specimen figured by White as *S.* (*M.*) *paludinaeformis* is a typical example of the species. The specimens figured by Mark, one under that name and the other as *Soleniscus brevis* do not show apertural views, but both seem to be young specimens of the species in question, as do the two specimens figured by Girty, one as *Sphaerodoma ventricosa*

and the other as *S. brevis*, variety. The specimens figured by Morningstar as *S. brevis* are typical examples of *S.* (*M.*) *paludinaeformis*.

The four specimens figured by Morgan (loc. cit.) as *Sphaerodoma brevis*, *S. gracilis* and *S. intercalaris* seem quite certainly to belong here. The second is quite the largest specimen figured in the literature.

I can not vouch for Keyes' three citations (3, p. 423, pl. 20, fig. 16; 10, p. 308; 34, p. 262) and that of Herrick (33, pl. 11, fig. 10) since they are without descriptions or adequate figures.

I have in all 136 specimens assigned to this species from the following horizons and localities. Locality 43, top of the Labette shale, 24 specimens from Zone G, 17 from Zone R and 85 unallocated to zones. Locality 6; 2 specimens from the top of the Labette shale. I have 6 specimens from the lower Fort Scott limestone of which 2 are from locality 7, 3 from Locality 10 and 1 from Locality 57. Cyrioplesiotype, Yale Peabody Museum, No. 13153.

SOLENISCUS (MACROCHILINA) BREVIS WHITE

Plate 24, figure 1 a-h, Plate 27, figure 7

Soleniscus brevis WHITE, *1881*, U. S. Geog. Survey W. 100 Merid., vol. 3, Supp., Appendix, p. xxviii, pl. 4, figs. 5 a-c. Pennsylvanian, Coyote Creek and Taos, New Mexico.

Solenscus (*Macrocheilus*) *ventricosus* (Hall), WHITE, *1884*, in part, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, fig. 12 (not fig. 11); *1884*, in part, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 155, pl. 34, fig. 12 (not fig. 11). Pennsylvanian, Illinois

	A	B
Number of whorls	9[a]	8[a]
Height	17.5 mm.[a]	12.3 mm.[a]
Width	11.5 mm.	8.7 mm.
Ratio of height to width	1.52	1.41
Ratio of height of body whorl to total	.85	.81
Pleural angle	71°	80°
Angle made by siphonal fold with columella	68°	79°

A The cyrioplesiotype (pl. 24, figs. 1f, 1g). A seemingly fully grown individual.
B A plesiotype (pl. 24, figs. 1d, 1h). A three-quarters grown individual.

[a]Estimated on the assumption that 2 apical whorls are missing.

Of moderate size; pear-shaped, with moderately large body whorl and somewhat tapering spire, sides of spire concave at neanic stages, convex at ephebic; whorl profile gently and evenly arched; sutures but slightly impressed, inductura only moderately thickened; siphonal fold prominent, with deep anterior face, bordered posteriorly by a relatively narrow and deep depression; siphonal channel deep and moderately wide; surface smooth, almost polished; growth lines faint; color in life a uniform dark gray, almost black.

This species is so close to *S. (M.) paludinaeformis* that its description necessarily reads about the same. And yet among the very considerable number of specimens of both species in my collections the lower spire and slightly more robust form of *S. (M.) brevis* is correlated with the sharper siphonal fold set at a higher angle to the columella. Since these characters do correlate, it seems necessary to regard the forms as distinct, however closely they resemble each other in other respects. *S. (M.) brevis* is less robust than *S. (M.) primigenius* and may further be distinguished readily by its sharper, more transverse siphonal fold. It approaches somewhat *S. (M.) medialis* but among other differences lacks the tremendously thickened inductura of that species.

There can be little doubt of the identity of my specimens with White's species. Both White's figures 5b, the lectotype (2, p. 202) and figure 5c show the general form and the very transverse siphonal fold. White's figure 5a seems to have a higher spire and a more oblique siphonal fold and would perhaps be better placed under *S. (M.) paludinaeformis*. Of the two specimens figured later by White, one, figure 11, is

---

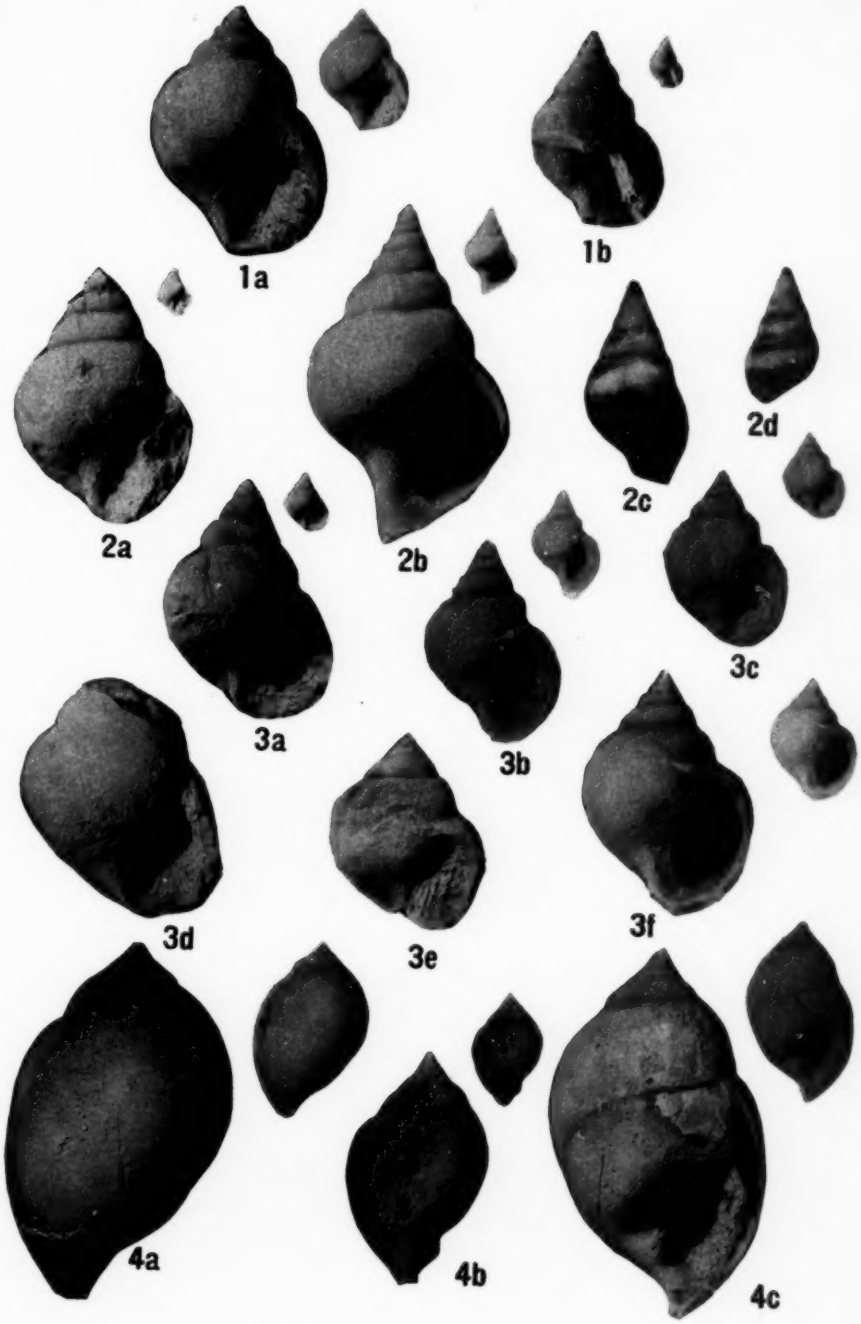
EXPLANATION OF PLATE 25

FIGS. 1 *a-b—Auriptygma subtilistriatum* Knight, n. sp. All specimens are from the St. Louis outlier. *a*, The holotype, (×2). *b*, A paratype, (×4). The ornamentation on this specimen can be seen on close examination.

2 *a-d—Auriptygma virgatum* Knight, n. sp. All specimens are from the St. Louis outlier. *a*, A paratype, (×6). *b*, The holotype, (×4). The outer lip is broken away for about ¼ whorl. The character of the inductura and the obscure syphonal fold can be seen. *c*, and *d*, Two paratypes photographed so as to show the color banding of this species, (approximately × 3.4).

3 *a-f—Auriptygma simplex* Knight, n. sp. All specimens are from the St. Louis outlier. *a*, A paratype, about ¼ grown, (×4). *b*, and *c*, Two paratypes, a little less than ½ grown, (×2). *d*, A large imperfect specimen referred to the species, (×1). It lacks most of its earlier whorls and is distorted by mashing, though very little of the outer lip is lost. *e*, A rather large specimen lacking the anterior end of the columella and about 1-6 whorl of the outer lip. *f*, The holotype, (×2). A specimen of about 1-3 to ½ full growth. The outer lip and a little of the anterior margin is broken away though the former seems to be intact at the upper suture.

4 *a-c—Soleniscus* (*Macrochilina*) *medialis* (Meek and Worthen). All specimens are from the St. Louis outlier. *a*, Dorsal view of a fully grown (?) specimen, (×2). A plesiotype from the lower Fort Scott limestone. *b*, A plesiotype, (×2). A half grown specimen from the top of the Labette shale. *c*, The cyrioplesiotype, (×2). A fully grown (?) specimen from the top of the Labette shale. Note the tremendously thickened inductura and the siphonal fold at a low angle with the columella. The outer lip is broken away for about ¼ whorl.



Knight, Pennsylvanian Gastropods

a young example of *S. (M.) primigenius*, but the other, figure 12, seems properly placed here.

My collections contain 61 specimens, one of which, a juvenile, is from the lower Fort Scott limestone at Locality 7. The remaining 60 are from the top of the Labette shale, two from Locality 6, and 58 from Locality 43. Of the latter 11 are from Zone G, 19 from Zone R while 28 are unallocated. Cyrioplesiotype, Yale Peabody Museum, No. 13154.

SOLENISCUS (MACROCHILINA) MEDIALIS (MEEK AND WORTHEN)

Plate 25, figures 4 a-c, Plate 27, figure 9

Macrocheilus medialis MEEK AND WORTHEN, *1860*, Phila. Acad. Nat. Sci., Proc., p. 466; *1866*, Ill. Geol. Survey, vol. 2, p. 370, pl. 31, figs. 5a, b. Pennsylvanian, Springfield, Illinois.

	A	B	C
Number of whorls	10[a]	9½[a]	9
Height	24 mm.	23.5 mm.	16 mm.
Width	14.5 mm.	15.0 mm.	10.2 mm.
Ratio of height to width	1.65	1,55	1.56
Ration of height of body whorl to total	.88	.90	.78
Pleural angle	68°	85°	71°
Angle made by siphonal fold with columella	[b]	[b]	[b]

A. The cyrioplesiotype (pl. 25, fig. 4 c). Apparantly a fully grown individual.
B. A plesiotype (pl. 25, fig. 4 a). Apparently a fully grown individual.
C. A plesiotype (pl. 25, fig. 4 b). A three-quarters grown individual.

[a]Estimated on the assumption that 2 apical whorls are missing.
[b]Not sufficiently well exposed on any of the specimens to be measured with any accuracy. However, it seems to be a low figure somewhere around 40°.

Of moderate size; sub-oval, with relatively long body whorl; sides of spire concave at neanic and markedly convex at ephebic stages; sutures but slightly impressed; suture of the final whorl of fully grown individuals more oblique than those of the younger whorls; inductura tremendously thickened just within the aperture of fully grown individuals and only to a less degree in younger ones; upper part of the thickened inductura of some specimens marked with faint, vertical grooves; siphonal folds distinct, bordered posteriorly by a rather narrow, deep groove in the inductura, the latter swelling out above the groove into the semblance of a low, rounded fold; siphonal channel wide and shallow; surface smooth, almost polished, growth lines faint; color in life seemingly uniform dark gray, almost black.

The identification of my specimens with Meek and Worthen's species rests upon the original description and figures, for though I have at hand what is purported to be the holotype, it is a typical example

of *S.* (*M.*) *primigenius* and fits neither the description nor figures of *M. medialis* and fails to fit them in particulars that could hardly be accounted for by errors in drawing and describing. The chief differences between Meek's example and mine are first its greater size and second its apparently flattened columellar lip. The authors attribute this latter to an error of the engraver. The drawing of the inductura also seems to leave something to be desired.

EXPLANATION OF PLATE 26

FIGS. 1—*Soleniscus* (*Macrochilina*) *altonensis* (Meek and Worthen). The holotype (×1). From the Worthen collection at the University of Illinois.

2—*Soleniscus* (*Macrochilina*) *intercalaris* (Meek and Worthen). The holotype, (×1). From the Worthen collection at the University of Illinois.

3 *a-b*—*Soleniscus* (*Cylindritopsis*) *ovalis* (Gemmellaro). The holotype, (×1). After Gemmellaro: I have inverted Gemmellaro's figures feeling that the American conventional orientation is preferable if only for the sake of uniformity. The lighting is then of course contrary to the usual convention. *a*, Dorsal view. *b*, Apertural view.

4 *a-b*—*Soleniscus* (*Bulimorpha*) *bulimiformis* (Hall). Topotypes from the Yale Peabody Museum collections. *a*, Apertural view, (×8). *b*, Specimen with wall of next to last whorl broken away to show arcuate columella with siphonal fold and channel well down toward the anterior parietal wall.

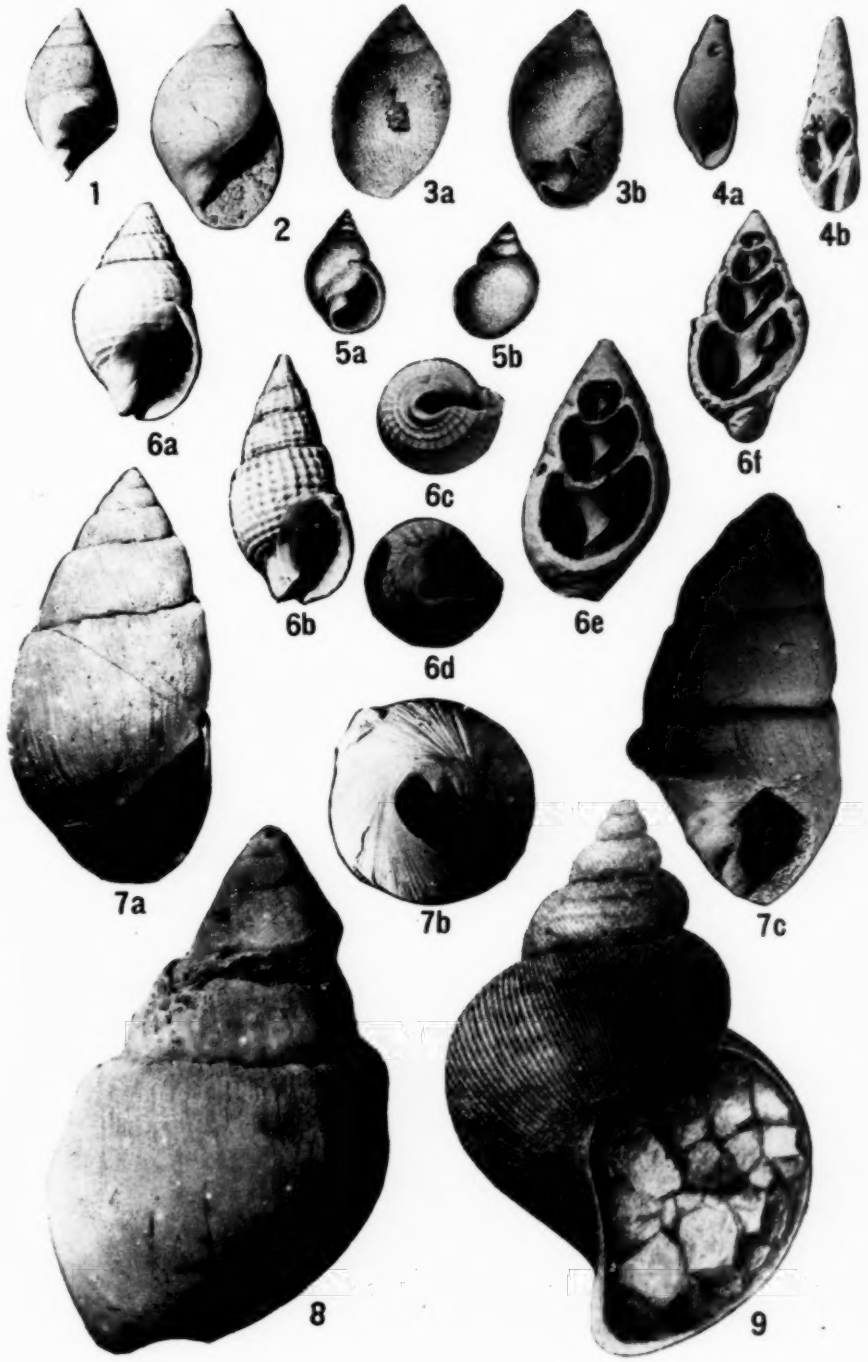
5 *a*—*Soleniscus* (*Macrochilina*) *ventricosus* (de Koninck). (Not Hall). After de Koninck. The genotype of *Strobeus* de Koninck. *a*, Apertural view. I have again reversed the orientation often employed by continental European authors.

6 *a-f*—Two species of the rachiglossate genus *Nassa* for comparison of the shell morphology of known siphonate gastropods with that of the Paleozoic forms under discussion as typified by *S.* (*M.*) *schlotheimi* (figs. 7 7 *a-c* just below). *a*, Apertural view of *N. obsoleta*. *b*, Apertural view of *N. trivittata*. *c*, and *d*, Basal views of *N. trivittata* and *obsoleta* respectively showing siphonal notch. *e*, and *f*, Dorsal views of *N. obsoleta* and *trivittata* respectively with shell wall cut away to show columella with siphonal fold and channel.

7 *a-c*—*Soleniscus* (*Macrochilina*) *schlotheimi* (d'Arch. and de Vern.). Specimens from the Yale Peabody Museum collections. *a*, Apertural view of a perfect specimen, (×1). *b*, basal view of the same specimen, (×1). *c*, Apertural view of a specimen with outer lip broken away for about ½ whorl, (×1). Note the sharp fold on the columella and compare it with the siphonal folds shown by the two Nassas. Note the close similarity of the basal views. Note also in connection with the generic characters, the obscure posterior fold in the inductura above the siphonal fold.

8—*Soleniscus* (*Macrochilina*) *arculata* (Schlotheim). Specimen from the Yale Peabody Museum collections. Dorsal view of a topotype specimen, (×1).

9—*Auriptygma fortior* (Barrande), Perner, (approximately × 3). After Perner. The genotype of *Auriptygma* Perner.



Knight, Pennsylvanian Gastropods

This species is close to *S.* (*M.*) *altonensis* (Meek and Worthen) the holotype of which is refigured on Plate 6, figure 1, but that species has a more slender form and longer spire. The sides of the spire of *S.* (*M.*) *altonensis* are moreover gently convex throughout. Both species have in common the greatly thickened inductura.

Both species share their general form with *S.* (*M.*) *intercalaris* (Meek and Worthen), the holotype of which may be seen on Plate 26, figure 2, but in the last the inductura is only moderately thickened.

I have five specimens referable to this species all of them in an excellent state of preservation. Two of them are from the lower Fort Scott limestone at Locality 7 and three from the top of the Labette shale at Locality 43. Cyrioplesiotype, Yale Peabody Museum, No. 13155.

SOLENISCUS (MACROCHILINA) WELLERI, KNIGHT, N. SP.
Plate 23, figures 1 a-d

	A
Number of whorls	6
Height	4.34 mm.
Width	3.83 mm.
Ratio of height to width	1.13
Ratio of height of body whorl to total	.89
Pleural angle	113°
Angle made by siphonal fold with columella	85°

A. Holotype (pl. 23, figs. 1 a-d).

Very small; sub-globular, with large body whorl and very short mammillary spire, sides of spire slightly concave; sutures very slightly impressed; inductura thickened; siphonal fold sharp, with sloping posterior and sharply undercut anterior face, bordered posteriorly by a shallow groove; posterior part of inductura not raised into semblance of a second fold; siphonal channel deep and narrow, surface smooth; growth lines faint, dark pigmentation confined to or only preserved on the edges of former aperture and on the inductura.

This small species is not easy to confuse with any known to me except *Soleniscus* (*Cylindritopsis*) *vaningeni* which differs in the possession of a strong parietal fold. The two species could not be distinguished unless the apertures are freed of matrix. The new species seems to be a quite unique but valid member of the subgenus *Macrochilina*.

The name is in honor of my former friend and instructor, the late Professor Stuart Weller of the University of Chicago.

I have three specimens ranging in size from less than 1½ mm. long to that of the holotype as shown above. All of these are from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 13156.

SOLENISCUS (MACROCHILINA) REGULARIS (Cox)

Plate 24, figures 2 a-n, Plate 27, figure 10

Loxonoma regularis Cox, *1857*. Ky. Geol. Survey, vol. 3, p. 566, pl. 8, fig. 2. Pennsylvanian, Daviess County, Kentucky.

Loxonema newberryi Stevens, *1858*, Am. Jour. Sci. and Arts, (2 ser.), vol. 25, p. 259. Roof of the Danville coal Pennsylvanian, Danville, Illinois.

Loxonema carinata Stevens, *1858*, loc. cit., p. 259. Roof of the Danville coal, Pennsylvanian, Danville, Illinois.

Macrocheilus fusiformis Hall, *1858*, Iowa Geol. Survey, Rept., vol. 1, pt. 2, p. 718, pl. 29, fig. 7. Pennsylvanian, Alpine Dam, Des Moines River, Iowa. (Not *Polyphemus fusiformis* Sowerby, 1840: here referred to the genus *Soleniscus*, subgenus *Macrochilina*).

Macrocheilus newberryi (Stevens), Hall, *1858*, loc. cit., p. 719, pl. 29, fig. 9. Pennsylvanian, Danville, Illinois. Meek and Worthen, *1873*, Ill. Geol. Survey, vol. 5, p. 594, pl. 28, fig. 14 Pennsylvanian, Danville, Illinois.

Polyphemopsis inornata Meek and Worthen, *1860*, Phila. Acad. Nat. Sci., Proc., p. 465; *1866*, Ill. Geol. Survey, vol. 2, p. 374, pl. 31, figs. 8 a-c. Pennsylvanian, Springfield, Illinois.

Polyphemopsis chrysalis Meek and Worthen, *1866*, Phila. Acad. Nat. Sci., Proc., p. 267; *1873*, Ill. Geol. Survey, vol. 5, p. 596, pl. 28, fig. 7. Pennsylvanian, Hodges Creek, Macoupin County, Illinois.

Polyphemopsis fusiformis (Hall), White, *1881*, Ind. Bur. Statistics and Geol., 2nd Ann. Rept. for 1880, p. 519, pl. 8, fig. 6; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 164, pl. 32, fig. 6, the same specimen as the foregoing but cited as *Polyphemopsis* ? sp. Pennsylvanian, Newport, Indiana.

?*Soleniscus planus* White, *1881*, U. S. Geol. Survey, W. 100 Merid., Supp. Append., p. xxix, pl. 4, figs. 4 a-c. Pennsylvanian. New Mexico.

Soleniscus (*Macrocheilus*) *fusiformis* ? (Hall), White, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 4-6; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 154, pl. 34, figs. 4-6. Pennsylvanian, Illinois and Indiana.

Soleniscus (*Macrocheilus*) *newberryi* (Stevens), White, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 7, 8; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 153, pl. 30, figs. 7, 8.

Soleniscus planus White, *1884*, U. S. Nat. Mus., Proc., vol. 6, p. 187, pl. 8, figs. 9, 10; *1884*, Ind. Dept. Geol. & Nat. Hist., 13th Rept., p. 153, pl. 34, figs. 9, 10. Pennsylvanian, Danville, Illinois.

Macrocheilus regularis (Cox), Whitfield, *1891*, N. Y. Acad. Sci. Annals., vol. 5, p. 600, pl. 15, fig. 13; *1895*, Ohio Geol. Survey, vol. 7, p. 485, pl. 11, fig. 13. Pennsylvanian, Carbon Hill, Hocking County, Ohio.

Bulimorpha inornata (Meek and Worthen), Keyes, *1894*, Mo. Geol. Survey, vol. 5, p. 265, pl. 55, fig. 6 Pennsylvanian, Kansas City, Missouri.

Bulimorpha minuta (Stevens), Girty, *1915*, Mo. Bur. Geol. and Mines (2nd ser.), vol. 13, p. 362, pl. 29, figs. 4, 4a, 4b. Cherokee shale, Pennsylvanian, Garland, Henry County, Missouri.

Sphaerodoma paludinaeformis (Hall), Girty, *1915*, U. S. Geol. Survey Bull. 544, p. 207, pl. 24, figs. 5, 6, 6a. Wewoka formation, Oklahoma.

Soleniscus fusiformis (Hall), Morgan, *1924*, (Okla.) Bur. of Geol., Bull. 2, pl. 1, fig. 4.

	A	B	C	D	E	F
No. Whorls	17[a]	16[c]	12[c]	11[e]	10	9
Height	79 mm.[a,b]	56 mm.[c,d]	38.5 mm.[c]	26.5 mm.	20.5 mm.	10.5 mm.
Width	28.5 mm.	21 mm.	15.5 mm.	10.2 mm.	8.7 mm.	4 mm.
Ratio of height to width	2.76	2.65	2.48	2.60	2.36	2.63
Ratio of height of body whorl to total	.51	.57	.61	.59	.63	.65
Pleural angle	29°	33°	38°	26°	39°	27°
Angle made by siphonal fold with columella	51°	46°	?	41°	55°	38°

A. The cyrioplesiotype (pl. 24, figs. 2 m, n). A very large example.

B. A plesiotype (pl. 24, fig. 20). Three-quarters grown.

C. A plesiotype (pl. 24, fig. 21). About half grown, of relatively short, wide form.

D. A plesiotype (pl. 24, fig. 2 g). About one-third grown, a very slender specimen.

E. A plesiotype (not figured). About one-quarter grown, of relatively short, wide form.

F A plesiotype (pl. 24, fig. 2 b). This specimen is of about the same size and proportions as the holotype of *Polyphemopsis inornata* M. & W.

[a]Estimated on the assumption that 6 apical whorls are missing.
[b]Allowing 5 mm. for restoring anterior margin.
[c]Estimated on the assumption that 4 apical whorls are missing.
[d]Allowing 3 mm. for restoring anterior margin.
[e]Estimated on the assumption that 2 apical whorls are missing.

Relatively large; slender; high-spired; sides of spire straight or very gently convex; whorl profile very gently arched; sutures very slightly impressed; inductura moderately thickened; siphonal fold rounded but distinct, bordered posteriorly by a moderately wide shallow depression; siphonal channel rounded, moderately narrow; surface smooth, almost polished; growth lines faint; color in life a uniform dark gray, almost black.

S. (*M.*) *regularis* seems to be one of the two relatively large, fusiform species referable to the subgenus *Macrochilina*. The other, *S.* (*M.*) *klipparti* Meek, is to be differentiated by means of its method of coiling, which makes the sides of the spire notably concave at earlier stages,convex when about half grown and subcylindrical at the last stages. Its whorl profile is also more strongly arched. The pleural angle of *S.* (*M.*) *regularis* shows considerable variation and some young specimens that approach the maximum if taken alone may easily be considered distinct species.

This species as represented not only in the synonymy but in my own collections has been a particularly difficult one to deal with. It is very doubtful that I should have come to the conclusion that all of my many

specimens were of a single species if it were not for the fact of practically complete intergradation in size from about 2 mm. length up to 8 mm. and in pleural angle from about 25° to about 40°. There may be more than one species in my collections and in the synonymy, but if there are I am at a loss to distinguish them.

Though the original illustration of *Loxonoma regularis* is far from satisfactory, the very high, many-whorled spire and general form suggests strongly that we have to do with that species. In dealing with *Loxonema newberryi* Stevens, *L. carinata* Stevens and *Soleniscus planus* White we apparently have to do with about half grown specimens leaning toward the end of the series with the wider pleural angle and more convex sides of the spire. However, as there seems to be complete intergradation in these respects, I cannot hold them as distinct. I have had the privilege of examining the metatype of *L. newberryi* used by Hall to illustrate that species for the first time (see pl. 24, fig. 2d). I have also examined the holotype of *Macrocheilus fusiformis* Hall (pl. 24, fig. 2h). The latter is a very poor specimen, but it seems reasonably certain that it belongs here.

Polyphemopsis inornata Meek and Worthen and *P. chrysalis* Meek and Worthen seem also to be synonyms of *S. (M.) regularis* as they are identical with, or at least cannot be distinguished from young specimens of the last. The holotype of the first mentioned species is figured on Plate 23, figure 2a.

Bulimorpha minuta (Stevens) as identified by Girty (loc. cit.) seems also to fall unto the category of young specimens of the species under consideration, as does his identification of *Sphaerodoma paludinaeformis* (Hall) cited above, although the latter falls among the forms with a wider pleural angle.

I have in my collections 172 specimens of which 159 are of less than 10 mm., and 14 of more than 35 mm. in length. Of these latter, 11 are steinkerns.[1] From Locality 43 were derived 159 specimens, one of which came from the lower beds of the Pawnee limestone, 102 from Zone G at the top of the Labette shale, 37 from Zone R with 19 specimens from the Labette shale unallocated as to zones. It should be mentioned that the majority of specimens with the larger pleural angle are from Zone R and the majority with the smaller angles are from Zone G. The top of the Labette shale at Locality 53 yielded a single specimen and the Pawnee

[1] I much prefer the simple and expressive German *steinkern* to our vague and inexact internal mold (or is it internal cast?).

limestone at Locality 6, six small specimens. Five specimens were derived from the lower Fort Scott limestone, 3 from Locality 7, and one each from Localities 10 and 42. The "Chaetetes" limestone at Locality 28 has yielded a single large steinkern. Cyrioplesiotype, Yale Peabody Museum, No. 13157.

SUBGENUS CYLINDRITOPSIS GEMMELLARO, EMEND. KNIGHT

SOLENISCUS (CYLINDRITOPSIS) VANINGENI KNIGHT, N. SP.

Plate 21, figures 3 a-d, Plate 27, figure 4

	A	B
Number of whorls	6[a]	6[b]
Height	5.0 mm.	4.5 mm.
Width	4.7 mm.	4.5 mm.
Ratio of height to width	1.1	1.0
Ratio of height of body whorl to total	.80	.88
Pleural angle	88°	100°
Angle made by siphonal fold with columella	84°	78°

A. The holotype (pl. 21, figs. 3a, 3b, 3d).
B. Paratype (pl. 21, fig. 3c).

[b]Estimated on the assumption that 1 apical whorl is obscured.
[a]Estimated on the assumption that 3 apical whorls are missing.

Small, sub-globular, with large body whorl and short mammillary spire; sides of spire gently convex; sutures very slightly impressed, siphonal fold elevated, with rounded edge, flat posterior and slightly undercut anterior face, bordered posteriorly by a deep, narrow groove and a second fold; posterior fold variable but often almost as well developed as the siphonal fold, though sharper at the edge and with more sloping posterior face, bordered posteriorly by shallow, subangular groove; inductura thick; siphonal channel deep and narrow; secondary thickening of outer wall forming a distinct, sloping shelf a short distance within the thin outer lip; surface smooth; growth lines faint; color in life seemingly a uniform dark gray, almost black.

This interesting little form, the first of the subgenus to be recognized from rocks older than the Permian, is to be distinguished by its small size, sub-globular form and its two remarkably prominent columellar folds. Its general form is very close to that of *S.* (*Macrochilina*) *welleri* and if the apertures are obscured it is very difficult to distinguish them. However, *S.* (*C.*) *vaningeni* is not quite so globular as that form which latter also has a sharper siphonal fold and, of course, lacks the second fold altogether.

The name is in honor of the late Professor Gilbert van Ingen of Princeton University who first inspired me with an abiding interest in the study of fossil invertebrates.

I have 9 specimens of this species all from the top of the Labette shale at Locality 43. Of these 6 were derived from Zone R and 3 from Zone G. Holotype, Yale Peabody Museum, No. 13158.

EXPLANATION OF PLATE 27

Columellar sections, greatly enlarged. All specimens, except Fig. 2, from the St. Louis outlier.

FIGS. 1—*Ceraunocochlis fulminula* Knight, n. sp. Part of final whorl broken away. Note the thin, fragile columella.

2—*Auriptygma fortior* (Barrande), Perner. After Perner. Note the low, obscure siphonal fold shown in section.

3—*Auriptygma virgatum* Knight, n. sp. Part of the final whorl broken away. Note the low, obscure columellar fold shown in section, and other characters that ally this specimen with *Auriptygma* and differentiate it from *Soleniscus* (sensu lato).

4—*Soleniscus* (*Cylindritopsis*) *vaningeni* Knight, n. sp. Note strong siphonal and posterior folds in final whorl. Both these and the thick inductura are resorbed within the earlier whorls. The section is not quite centered on the columella in the next to last whorl.

5—*Soleniscus* (*Macrochilina*) *primigenius* (Conrad). A little more than ½ the last whorl is missing from this specimen. Note the relatively low siphonal fold in the final whorl and that it and more besides is resorbed in preceding whorls. Also note the filling of the earlier whorls from the outer walls inward.

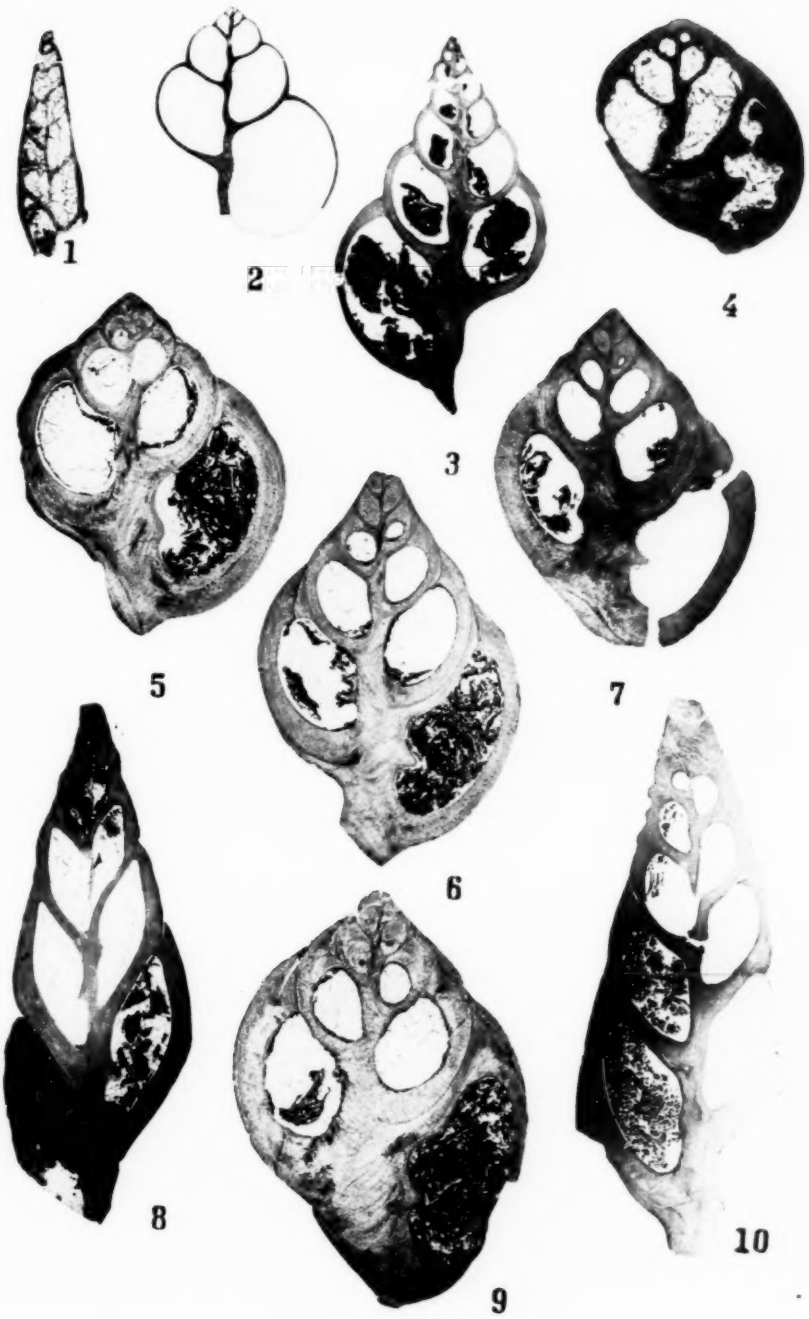
6—*Soleniscus* (*Macrochilina*) *paludinaeformis* (Hall). About ½ of the last whorl is missing from this specimen. This specimen shows beautifully the resorption of the siphonal fold and the inductura while the outer walls are built in until the earlier whorls are filled.

7—*Soleniscus* (*Macrochilina*) *brevis* (White). About ½ the final whorl of this specimen is broken away.

8—*Soleniscus* (*Soleniscus*) *typicus* Meek and Worthen. The section is not well centered on the columella and the specimen lacks the final ½ whorl. Both the siphonal and posterior folds can be seen in the next to last whorl. Note the lanceolate cross-section of the whorl opening as compared with the sub-oval to palette-shaped opening of the specimens of the other forms.

9—*Soleniscus* (*Macrochilina*) *medialis* (Meek and Worthen). The outer lip of this specimen is cut about ¼ whorl back of its true edge. Note how thin this wall is as compared with the outer walls of earlier whorls.

10—*Soleniscus* (*Macrochilina*) *regularis* (Cox). The entire final whorl of this specimen is broken away. Note the resorption of columellar characters and the building up of the outer walls and filling of the earlier whorls just as in the more robust of the Pennsylvanian specimens of this subgenus and of *Cylindritopsis*. Though in the outer form of this species suggests close relationship to *Soleniscus* (sensu stricto) its apertural and inner characters ally it with the subgenus *Macrochilina*.



Knight, Pennsylvanian Gastropods

GENUS AURIPTYGMA PERNER, EMEND. KNIGHT

AURIPTYGMA SUBTILISTRIATUM KNIGHT, N. SP.

Plate 25, figures 1 a, b

	A	B
Number of whorls	9[a]	7
Height	17.5 mm.[b]	7.0 mm.[b]
Width	12 mm.	4.75 mm.
Ratio of height to width	1.46	1.46
Ratio of height of body whorl to total	.80	.71
Pleural angle	63°	64°

A. The holotype (pl. 25, fig. 1a). A large individual probably fully mature.
B. A paratype (pl. 25, fig. 1b). A specimen about one-third grown.

[a]Estimated on the assumption that 3 apical whorls are missing.
[b]Allowing about 1 mm. for restoration of anterior margin.

Of moderate size; moderately robust; naticoid; spire distinct, nearly straight-sided, whorl profile well arched; sutures relatively deep; inductura thin, perhaps wanting over the inflated belly of the preceding whorl, slightly thickened in the posterior angle of the aperture and on and just above the columella; siphonal fold low, indistinct; surface covered with low, rounded transverse lirae, 4 or 5 to the millimeter on the 8th whorl; lirae indicate outer lip to have had a slight forward convexity with a general obliquity downward and backward from the suture; pigmentation not well preserved in any specimens seen but there is a suggestion of a uniform gray color.

This form may be differentiated among the Pennsylvanian species known to me by the possession of fine but regular distinct transverse lirae much as in the Silurian type of *Auriptygma*.

My collections contain 6 specimens of this species ranging in size from less than 2 mm. to that of the holotype. All of these are from the top of the Labette shale at Locality 43, and 2 of them are known to have been derived from Zone G. Holotype, Yale Peabody Museum, No. 13160.

AURIPTYGMA SIMPLEX KNIGHT, N. SP.

Plate 25, figures 3 a-f

Sphaerodoma brevis (White), GIRTY, *1915*, (in part), U. S. Geol. Survey, Bull. 544, p. 201, pl. 24, figs. 8, 8a, 8b. Wewoka formation, Pennsylvanian, Oklahoma.

	A	B	C	D
Number of whorls	8	9	10	6
Height	16 mm.	26 mm.	35 mm.	8 mm.
Width	11.3mm.	20 mm.	27 mm.	5.8 nn.
Ratio of height to width	1.42	1.30	1.30	1.39
Ratio of height of body whorl to total	.78	.77	.75	.73
Pleural angle	77°	79°	73°	73°

A. The holotype (pl. 25, fig. 3f). A well preserved specimen about one-half grown.

B. A paratype (pl. 25, fig. 3e). Apparently a three-quarters grown individual.

C. A paratype (pl. 25, fig. 3d). A large, poorly preserved specimen, probably fully grown.

D. A paratype (pl. 25, fig. 3a). A rather young individual, about one-quarter grown.

Owing to the poor preservation of this specimen the measurements are largely estimates.

Relatively large; moderately robust, naticoid; spire distinct, its sides very slightly concave; whorl profile well arched; sutures relatively deep; inductura thin, perhaps wanting over the inflated belly of the preceding whorl, thickened in the posterior angle of the aperture and on and just above the columella, siphonal fold low, indistinct, almost obsolete; surface almost smooth, but marked with numerous irregularly spaced and relatively conspicuous growth lines; pigmentation indicates a dark gray, almost black color in life.

A. simplex is seemingly the largest of the three members of the subgenus described here; it lacks the regular transverse lirae of *A. subtilistriatum* and differs from *A. virgatum* in its larger size, more robust form and relatively conspicuous lines of growth.

I am listing in the synonymy one of the specimens figured by Girty (loc. cit.) as *Sphaerodoma brevis* (White).

I have 21 specimens of this species ranging from about 4 mm. in height to the size of the largest specimen shown in the above tabulation. Two specimens were derived from the lower Fort Scott limestone at Locality 10, two from the top of the Labette shale at Locality 6, and 17 from the latter horizon at Locality 43. Of the last, 6 came from Zone R and 3 from Zone G. Holotype, Yale Peabody Museum, No. 13161.

AURIPTYGMA VIRGATUM KNIGHT, N. SP.

Plate 25, figure 2 a-d, Plate 27, figure 3

Sphaerodoma gracilis (Cox), GIRTY, *1915*, U. S. Geol. Survey, Bull. 544, p. 204, pl. 24, figs. 3, 3a. Wewoka formation, Pennsylvanian, Oklahoma.

	A	B
Number of whorls	9	7[a]
Height	12.0 mm.	6 mm.
Width	7.0 mm.	3.9 mm.
Ratio of height to width	1.71	1.53
Ratio of height of body whorl to total	.69	.68
Pleural angle	62°	62°

A. The holotype (pl. 25, fig. 2b). My largest specimen, possibly fully mature.

B. A paratype (pl. 25, fig. 2a). A half grown individual.

[a]Estimated on the assumption that 2 apical whorls are missing.

Relatively small; moderately robust, with rather high spire; sides of spire very slightly concave; whorl profile well arched; sutures deep; inductura thin, perhaps wanting in a narrow strip over the inflated belly of the preceding whorl, thickened in the posterior angle of the aperture and on and just above the columella; siphonal fold low, relatively indistinct; surface smooth without ornamentation of any sort and with only very obscure growth lines; the coloration beautifully preserved on a number of specimens consists of a black nucleus and two dark revolving bands on the whorls.

A. virgatum is to be distinguished from the other two species here described by its smaller, more slender form, lack of any sculpture but the faintest growth lines and, if they are preserved, by its revolving color bands.

I am listing in the synonymy only Girty's identification of a specimen from the Wewoka formation as *Sphaerodoma gracilis* (Cox). While Girty's specimen did not have a well preserved inner lip and he was therefore doubtful as to whether or not it had a columellar fold, the size and general form conform so closely to those characters in the species under consideration that I cannot but consider that Girty was dealing with the same thing.

Although *Ma rocheilus gracilis* Cox does not seem to be recognizable on the basis of any evidence at hand, it seems probable that it is not to be identified with any *Auriptygma*, for Cox's very poor figure shows clearly a rather thick inductura over the base of the preceding whorl.

I have 76 specimens of this species, all from the top of the Labette shale at Locality 43. Of these 36 were collected from Zone G, 5 from Zone R with 36 unallocated between these two zones. Holotype, Yale Peabody Museum, No. 13162.

REGISTER OF LOCALITIES

LOCALITY 6. "Davis Place" sub-division of Clayton, St. Louis County, Missouri The exposure was about 200 feet north of Clayton road on the first (unnamed) street west of Kirkwood-Ferguson trolley tracks and consisted of residual blocks of the lower two feet of the Pawnee limestone in place on Labette shale. It was the result of sub-division grading and is no longer exposed.

LOCALITY 7. Cut of the C. R. I. & P. Railroad, Bemiston Ave., Clayton, St. Louis County, Missouri. Lower Fort Scott limestone.

LOCALITY 10. Southeast corner of Wydown boulevard and Glenridge Avenue, Clayton, St. Louis County, Missouri. Exposure of lower Fort Scott limestone in place and weathered material of the same beds thrown out on surface from excavations. The result of sub-division work and no longer exposed.

LOCALITY 28. On the north side of Manchester Ave. (Cheltenham district), St. Louis, Missouri. Exposure made in grading sub-division. Three (new and unnamed) streets east of Tamm Ave., and three (new) streets north of Manchester Ave. Exposure Chaetetes (?) limestone, lower and upper Fort Scott limestone. Exposure temporary.

LOCALITY 42. Exposures of lower Fort Scott limestone in steep embankment in the rear of new buildings on Pershing Avenue at Cleveland Walk, University City, St. Louis County, Missouri. The result of sub-division grading and no longer exposed.

LOCALITY 43. Exposure along one of the headwater branches of Feefee Creek, 0.6 mile west of Lackland Station, C. R. I. & P. Railroad, and 1 mile northwest of Stratman, St. Louis County, Missouri. The section along this creek ranges from the shales below the Summit (?) coal horizon up through about 20 feet of the topmost massive sandstone of the section in the Pleasanton formation. The new belt boulevard extension of Denny road, Lindberg boulevard, has recently been put through this hollow and this excellent section will probably be available for many years to come.

LOCALITY 53. Along creek about one quarter mile northwest of Ascalon, St. Louis County, Missouri. Pleasanton sandstone exposed at head of draw, Pawnee limestone, top of Labette shale and lower Fort Scott limestone also exposed further down stream.

LOCALITY 57. Cut on abandoned right of way of "Belt Line" Railroad. One quarter mile south of Ferguson, St. Louis County, Missouri. Lower Fort Scott limestone.

REFERENCES

1. WHITE, C. A., Ind. Dept. Geol. & Nat. Hist., 13th Ann. Rept., 1884.

2. GIRTY, G. H., The Fauna of the Wewoka Formation of Oklahoma, U. S. Geol. Survey, Bull. 544, 1915.

3. KEYES, C. R., Am. Naturalist, vol. 23, p. 420 et seq., 1889.

4. PHILLIPS, J., Figures and descriptions of the Paleozoic Fossils of Cornwall, etc., 1841.

5. WOODWARD, S. P., A Manual of the Mollusca, 1851-56.

6. WANNER, C., Paläontologie von Timor, xi. Lieferung XVIII. Die Gastropoden and Lamellibranchiaten der Dyas von Timor, 1922.

7. CONRAD, T. A., Descriptions of new species of organic remains, etc., Phila. Acad. Nat. Sci. Jour., 1st ser., vol. 8, pp. 235 et seq., 1842.

8. PORTLOCK, J. E., Report on the Geology of the County of Londonderry, etc., 1843.

9. MILLER, S. A., North American Geology and Paleontology. 1889.

10. KEYES, C. R., The American species of *Polyphemopsis*. Phila. Acad. Nat. Sci., Proc., p. 299 et seq. 1889.

11. LINDSTROM, G., On the Silurian Gastropoda and Pteropoda of Gotland, Kongl. Svenska Vetenskaps-Akademiens Handlinger, Bandet 19, No. 6, 1884.

12. HALL, J., Descriptions of new species of fossils, etc., Albany (New York) Institute, Trans., vol. 4, p. 2-36., 1858.

13. MEEK, F. B. and WORTHEN, A. H., Phila. Acad. Nat. Sci., Proc., 1860.

14. BAYLE, E., Liste rectificative de quelques noms de Genres, Jour. de Conchyliologie, vol. 27, p. 34-35, 1879.

15. BAYLE, E., Liste rectificative, etc., Jour. de Conchyliologie, vol. 28, pp. 241-251, 1880.

16. DE KONINCK, L. G., Faune du Calcaire Carbonifère de la Belgique, vol. 11, part 3, 1881.

17. WHITFIELD, R. P., On the fauna of the lower Carboniferous limestones of Spergen Hill, Indiana, etc., Am. Mus. Nat. Hist., Bull., vol. 1, pp. 39-97, 1882.

18. WHITE, C. A., On the *Macrocheilus* of Phillips, *Plectostylus* of Conrad, and *Soleniscus* of Meek and Worthen, U. S. Nat. Mus., Proc., vol. 6, 1884.

19. GEMMELLARO, G. G., La fauna dei calcari con Fusulina della valle del fiume Sosio, etc., Giornale di Scienze Naturali ed Economiche di Palermo, vol. 20, pp. 9-138, 1890.

20. PERNER, J., in Barrande, Système Silurien du Centre de la Bohême, vol. 17, pt. 2, 1907.

21. International Rules of Zoological Nomenclature, Biological Soc. Washington, Proc., vol. 39, pp. 75-104.

22. KOKEN, E., Ueber die Entwickelung der Gastropoden vom Cambrium bis zur Trias, N. Jahrb. f. Min., Geol. Pal., Beil. 6, pp. 305-484, 1889.

23. WAAGEN, WM., Productus limestone fossils, Geol. Survey India, Mem., ser. 13, vol. 1, 1887.

24. KOKEN, E., and PERNER, J., Die Gastropoden des Baltischen Untersilurs, Acad. des Science de Russie, Mem., sr. 8, vol. 37, No. 1, 1925.

25. ULRICH, E. C. and SCOFIELD, W. R., The Lower Silurian Gastropods of Minnesota, Geol. Minn., Final Rept., vol. 3, pt. 2, pp. 813 et seq.

26. COSSMAN, M., Essais de paléoconchologie comparée, vol. 8, 1909.

27. ZITTEL, K. A. VON, and EASTMAN, C. R., Text-book of Paleontology, 1900.

28. ZITTEL, K. A. VON, and BROILI, F., Grundzüge der Paleontologie, 1924.

29. FISCHER, P., Manuel de Conchyliologie, 1887.

30. KNIGHT, J. B., The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: The Pseudozygopleurinae. Jour. Pal., vol. 4, Supp. 1, 1930.

31. MORTON, S. C., in Hildreth, Observations on the Bituminous coal deposits of the valley of the Ohio, etc., Am. Jour. Sci., 1st ser., vol. 29, pp. 1-154, 1836.

32. KEYES, C. R., Paleontology of Missouri, Mo. Geol. Survey, vol. 5, 1895.

33. HERRICK, C. L., Bull. Sci. Lab. Denison Univ., vol. 4, pt. 1, 1888.

34. KEYES, C. R., Fossil fauna from central Iowa, Phila. Acad. Nat. Sci., Proc., 1891, p. 242, et seq., 1891.

35. WHITE, C. A., Fossils of the Indiana Rocks (No. 2), Ind. Dept. Geol. & Nat. Hist., 13th Ann. Rept., 1884.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 230-243, PL. 28, SEPTEMBER, 1931.

NEW CONODONTS FROM THE WOODFORD FORMATION OF OKLAHOMA[1]

C. L. COOPER[2]
Parkersburg, West Virginia

ABSTRACT

The Woodford formation, typically exposed in the Arbuckle Mountains of Oklahoma, was for many years, thought to be unfossiliferous. The author, working at intervals over a period of several years, has collected a very extensive fauna of these tooth-like organisms, conodonts, from several localities. More than sixty species have been described and identified. Of these 37 are new, including two new genera, *Hamulosodina*, represented by seven species and *Telumodina* by two species. The previously described forms are all Mississippian (Kinderhook) in age, comparable to those found in the Chattanooga shale of Alabama and Mississippi, the Hardin sandstone of Tennessee, the Sunbury and Ohio shales of Ohio, and the Sweetland Creek shale of Iowa.

INTRODUCTION

The author recently prepared a short paper[3] on conodonts in which were described 16 species, representing 9 genera from widely scattered localities in central United States. In that paper only those forms already described were used. The 16 species were obtained from seven localities: the Hardin sandstone, Mt. Pleasant, Tenn.; the Chattanooga shale, Huntsville, Ala.; the Sunbury shale, Columbus, Ohio; the Woodford formation, south of Ada, Okla.; the Woodford formation, Ti Valley, Oklahoma; and the Arkansas novaculite, T. 2 N., R. 21 E., Oklahoma.

Ulrich and Bassler and others[4] have commented on the value of these organisms for stratigraphic correlation. The present investigations, carried out under the auspices of the Oklahoma Geological Survey, and with the coöperation of others who have furnished material from

[1]Published by permission of the Director, Oklahoma Geological Survey.

[2]Formerly Chief Geologist, Oklahoma Geological Survey.

[3]Cooper, C. L., Some conodonts from the Arkansas novaculite, Woodford formation, Ohio shale and Sunbury shale: Jour. Pal., vol. 5, pp. 143-151, pl. 20, 1931.

[4]Bryant, William L., The Genesee conodonts: Bull. Buffalo Soc. Nat. Hist., vol. 13, no. 2, 1921.

Ulrich, E. O., and Bassler, R. S., A classification of the tooth-like fossils, conodonts, with descriptions of American Devonian and Mississippian species: Proc. U. S. Nat. Mus., vol. 68, art. 12, pp. 3, 4, 1926.

Holmes, Grace B., A bibliography of the conodonts with descriptions of early Mississippian species: Proc. U. S. Nat. Mus., vol. 72, art. 5, 1928. Describes conodonts from the Chattanooga shale of Alabama.

distant points and other formations, have, it is believed, justified the dependence which workers have placed on these very peculiar and intriguing forms. These fossils were discovered during investigations, carried on at intervals during the past three years, on the formations above the Hunton group and below the Caney shale in the Arbuckle Mountains of Oklahoma. Inasmuch as the publication of the final paper may be delayed for several months, these descriptions are being submitted for publication in advance of the entire report in order to make the new forms available to workers on correlative horizons in other areas.

The new genera and species described in the present paper are those found in one collection from the Woodford formation from sec. 3, T. 2 N., R. 6 E. Since this is the first collection exhaustively studied from the Woodford, it contains a large number of new forms. A total of more than sixty species have been found in this collection, 37 of which are new, including two new genera, all of which are described in the following pages.

The classification of these forms, as recently revised by Ulrich and Bassler[1] is followed in the present paper. The author has not yet had sufficient time, and in fact little material that would serve as a basis, for studies to determine the zoological affinity of these fossils. Various workers on these forms, both the earlier ones and those during the past ten years, have reached different conclusions concerning the derivation of the conodonts. Some, and the weight of evidence is probably in their favor, believe they are the teeth of primitive fishes, now extinct. Others think they are probably the masticatory organs of certain Annelida[2] and crustaceans. The suggestion has also been made that they somewhat resemble the lingual teeth of mollusks, the hooks of cephalopods, or the spines of crustacea. Bryant[3] and Holmes[4] both review the earlier workers' conclusions regarding these forms, and concur with Ulrich and Bassler in that they are the teeth of fishes, probably of the myxine and other types, now extinct.

[1] *Op. cit.*

[2] Zittel, Karl A., Textbook of paleontology, McMillan & Co., vol. 1, p. 140, 1927.

[3] *Op. cit.*, pp. 8-12.

[4] *Op. cit.*, pp. 1, 2.

SYSTEMATIC DESCRIPTIONS

FAMILY PRIONIODIDAE ULRICH AND BASSLER, 1926

GENUS PRIONIODUS PANDER, 1856

PRIONIODUS ALATOIDEUS COOPER, N. SP.

Plate 28, figure 1

The bar is straight and somewhat thin. Its length is unknown because the single available specimen is incomplete. The denticles are broad, fused, sharp pointed, and relatively long. The main cusp is more slender than in *P. alatoides* Holmes and more inclined forward. The posterior side of the downward projection of the cusp is at right angles to the bar; the whole projection is short and thick as compared with the width of the base of the cusp.

PRIONIODUS ARCUATUS COOPER, N. SP.

Plate 28, figure 3

Bar strongly arched, and compared with the length of the denticles, is rather thin. The denticles are slender, laterally fused, and longest in the middle of the bar, decreasing slightly in length toward the ends. The cusp is relatively short, with a very prominent projection below the bar. The broad curve of the front side of the cusp is very distinctive, making the tip of the cusp approximately at right angles to the bar, in contrast to the sharp forward inclination of the rest of the cusp. This species is not to be confused with any others of the genus because of the very decided arching of the bar and the curving of the cusp.

PRIONIODUS MACROCORNATUS COOPER, N. SP.

Plate 28, figure 2

The moderately thick bar is straight and carries a number of short, thin, discrete denticles which are inclined toward the anterior end and parallel to the main cusp. The most distinctive feature of this species is the very great development of the cusp, which is out of proportion compared with others of the genus. The inclination of the cusp is toward the front at a very obtuse angle. The projection is small, with the posterior side at right angles to the bar.

PRIONIODUS OBTUSUS COOPER, N. SP.

Plate 28, figure 4

The main characteristic of this species is the rounded projection somewhat similar to that found in the genus *Hindeodella* in contrast

to the pointed projection which is the rule. However, the cusp is strongly inclined forward at an obtuse angle with the bar, as in other species of *Prioniodus*. The bar is straight with a ridge along the lower edge. The denticles are discrete, somewhat slender, and approximately equal in length.

Family PRIONIODINIDAE Ulrich and Bassler, 1926

Genus PRIONIODELLA Ulrich and Bassler, 1926

PRIONIODELLA ACIEDENTATA Cooper, n. sp.

Plate 28, figure 6

The slightly curved bar is much thicker on the anterior than on the opposite end, which is a rounded termination formed by the final denticle. The denticles occur in two sets, the larger ones longer and flaring at the base, while the smaller ones, which are shorter and more slender than the others, alternate with them; the denticles of the larger set are subequal in size.

PRIONIODELLA CURVATA Cooper, n. sp.

Plate 28, figure 5

Bar gently curved, rather broad and short. The denticles are approximately equal in size; the largest are in the center and become slightly smaller toward each end. They are rather short, broad at the base and for most of their length, tapering rapidly to a sharp point in the upper part.

PRIONIODELLA MEGASTYLUS Cooper, n. sp.

Plate 28, figure 7

Bar thin and somewhat flattened, slightly curved, the posterior end broadly rounded to the final denticle; the anterior end abruptly terminated to the first denticle which sets on the bar at an acute angle. The denticles are subequal in size, the largest in center. The denticles curve slightly toward the posterior end in the lower third of their length, the remainder of the tooth being straight. The larger denticles are alternated by a single short, thin denticle.

Genus BRYANTODUS Ulrich and Bassler, 1926

BRYANTODUS ANGULATUS Cooper, n. sp.

Plate 28, figure 8.

Bar strongly arched, almost to form a right angle with the two ends, and the characteristic projection beneath the main cusp is well developed.

The cusp is broad at the base, tapering rapidly to a point, and very much inclined. The denticles, four in number, on the posterior (?) side (that toward which the cusp is inclined) are discrete, short and more delicate than those on the opposite side. This side has six short but broad denticles, which are fused in their lower half.

BRYANTODUS DELTOIDEUS COOPER, N. SP.
Plate 28, figure 10

The two ends of the bar are arched to form right angles with each other, the portion carrying the large denticles is slight y curved, while the opposite end is straight This species is similar to *B. angulatus*, except that the main cusp is much broader at the base, and the bar on the side with the small denticle is much narrower. The small denticles are discrete and very slender in their upper half. The large denticles on the opposite of the cusp are broad at the base, those nearest the cusp slightly inclined toward it.

BRYANTODUS EQUALIS COOPER, N. SP.
Plate 28, figure 9.

Somewhat similar to *B. inequalis* Holmes, but differs from that species in that it carries fewer denticles which are more nearly equal in length. The main cusp is broad at the base and inclined toward the narrower denticles as in other species of the genus. The bar is rather broad, slightly arched, and carrying the triangular projection beneath the main cusp.

BRYANTODUS SUBEQUALIS COOPER, N. SP.
Plate 28, figure 11

Form much smaller and carries fewer denticles than *B. inequalis* Holmes. The two sides of the bar vary much in width and in the general shape of the denticles. The cusp and denticles are decidedly inclined, and rather sharp pointed. The projection beneath the main cusp is very slightly developed.

GENUS EUPRIONIODINA ULRICH AND BASSLER, 1926

EUPRIONIODINA MACRODENTATA COOPER, N. SP.
Plate 28, figure 12

Bar long, straight and very slender, considering the very large cusp and denticles which it supports. The cusp and denticles incline strongly

toward the posterior end and are very little, if at all, curved. The cusp is broadly flaring at the base, tapering rapidly, so that the upper part is very slender. The denticles are very much the same except that they are shorter and correspondingly more slender. The three immediately behind the cusp are shorter than the next three. The final denticle is small and ends the bar in a strong curve. The downward projection is sharply terminated, and carries two upright denticles. The form is somewhat similar to *E. devonica* Hibbard,[1] described from the Rhinestreet shale of New York, but differs in the attitude of the denticles and cusp, and in the general aspect of the projection of the main cusp below the bar.

GENUS LONCHODINA ULRICH AND BASSLER, 1926

LONCHODINA ANGULATA COOPER, N. SP.

Plate 28, figure 13

Bar irregularly bowed, the part carrying the cusp making an acute angle with the left side. The median portion of the bar is much thinner than the sides and carries a long slender cusp which is flaring at the base. The denticles on the left side (the only one preserved) are upright, somewhat slender, sharp pointed and slightly curved. This species differs from *L. discreta* Ulrich and Bassler, in that the curve of the bar is more sweeping and not so angular, and from *L. irregularis* Holmes, in the weight of the bar, and the fewer number of denticles.

LONCHODINA SUBARCUATA COOPER, N. SP.

Plate 28, figure 14.

Bar slightly curved or arched, less so than *L. arcuata* Ulrich and Bassler. The largest cusp is located in the center of the bar, the other teeth becoming smaller toward either end. The teeth are all discrete, slender and somewhat tapering. The teeth are more or less parallel, standing upright from the bar.

GENUS HINDEODELLA ULRICH AND BASSLER, 1926

HINDEODELLA CURVIDENS COOPER, N. SP.

Plate 28, figure 15

The entire tooth larger and heavier than most species of this genus. The bar is strongly arched, and considering the massive nature of the denticles it carries, is relatively slender. The main cusp is long and

[1]Hibbard, R. R., Am. Jour. Sci., 5th ser. vol. 13, pp. 189-208, pls. 1-4, 1927.

tapering, with a decided curvature toward the back. Two long slender denticles occur in front of the cusp, projecting from the base at approximately right angles. The front part of the bar carrying these two denticles is very much thicker than any other part. Behind the cusp are two or three relatively short denticles, alternating with very much thinner and shorter ones. These are followed by four or five larger and thicker denticles, also alternated with smaller ones, as are those immediately in front. The larger denticles are strongly bent about one-third the way up from the bar, and are straight and tapering for the remainder of their length. The bar is terminated by a short, thick curved denticle.

HINDEODELLA CRASSIDENS COOPER, N. SP.
Plate 28, figure 16

The bar is slender, only very slightly curved, and the rounded anterior end terminated in a short sharp denticle. The cusp and larger denticles are very broad and tapering, and appear too heavy for the somewhat frail character of the bar. The cusp is broad at the base, is slightly curved toward the posterior end in the lower third, but is straight for the remainder of its length. The cusp is followed by two denticles intermediate in size between the largest and smallest ones. The posterior half of the bar carries three denticles which are a little over half the length of the cusp. These denticles, like the cusp, are broad at the base, and rapidly taper to a sharp point. The large and small denticles are alternated by two or more tiny denticles which are very short and slender.

HINDEODELLA SUBTILITA COOPER, N. SP.
Plate 28, figure 17

Bar extremely thin, carrying numerous straight slender denticles, alternated by two or three very fine hair-like ones. The bar in front of the cusp is very much depressed and carries two slender denticles much the size and shape of the larger ones behind the cusp. The bar is terminated posteriorly by a short, relatively thick, curved denticle. The main cusp is only slightly curved, very slender, and tapers to a sharp point.

HINDEODELLA PUMILLA COOPER, N. SP.
Plate 28, figure 18

A very short specimen having much the appearance of *H. subtilis* Ulrich and Bassler, except for its length and the more acutely depressed anterior end. The bar is short and relatively wide, and is terminated

posteriorly by a relatively long, slightly curved denticle. The cusp is slender and very slightly curved. The denticles in front of the cusp are four or more in number and of much the same character as the larger ones on the main part of the bar. These denticles are inclined away from the cusp, somewhat slender and less than half the ength of the cusp. The larger denticles are alternated by one or more smaller ones which are less than half their length.

HINDEODELLA SUBGRACILIS COOPER, N. SP.
Plate 28, figure 19

This species is somewhat similar to *H. curvidens* except that it is much smaller in size and the smaller denticles alternating with the larger ones are more numerous. The bar is slender and that part in front of the cusp is sharply deflected. This front part of the bar carries two very short and slender denticles. The cusp and larger denticles are somewhat broad at the base, tapering gradually to a sharp point. The cusp is slightly curved backward and is about 2½ times as long as the larger denticles. The main denticles grow in length and width along two-thirds of the length of the bar; the larger ones are therefore found on the posterior third. The bar is terminated posteriorly by two denticles, shorter than the main denticles, and which project backward so that they are almost parallel with the axis of the bar.

HINDEODELLA MEDIANA COOPER, N. SP.
Plate 28, figure 20

A specimen doubtfully referred to this genus because it has characteristics of *Prioniodina* and *Prioniodella*, but not referred to the former genus because the bar is straight and not to the latter because of the distinct cusp near the center of the bar. Also the denticulation more closely resembles *Hindeodella* than it does either of the two genera mentioned above. The bar is short and straight, carrying denticles which are all inclined in one direction at the same angle. Behind the cusp the main denticles are alternated by one or more smaller denticles, while in front of the cusp the denticles are discrete, and without the alternating smaller ones. The cusp is relatively short, slender, and of much the appearance of the main denticles behind it, though longer.

HINDEODELLA PETILA COOPER, N. SP.
Plate 28, figure 21

Front end of the bar and cusp are very massive compared with the remainder of the bar, which is somewhat delicate. The main denticles

are about one-fourth the length of the main cusp, and are alternated by two much smaller denticles. The main cusp is very broad at the base, tapering rapidly to a very slender tip. In front of this cusp is a single slender denticle curved in the same manner as the cusp. The bar of this species is somewhat longer than in others of the genus, carrying 11 sets of denticles.

HINDEODELLA MACRODENTATA COOPER, N. SP.
Plate 28, figure 22.

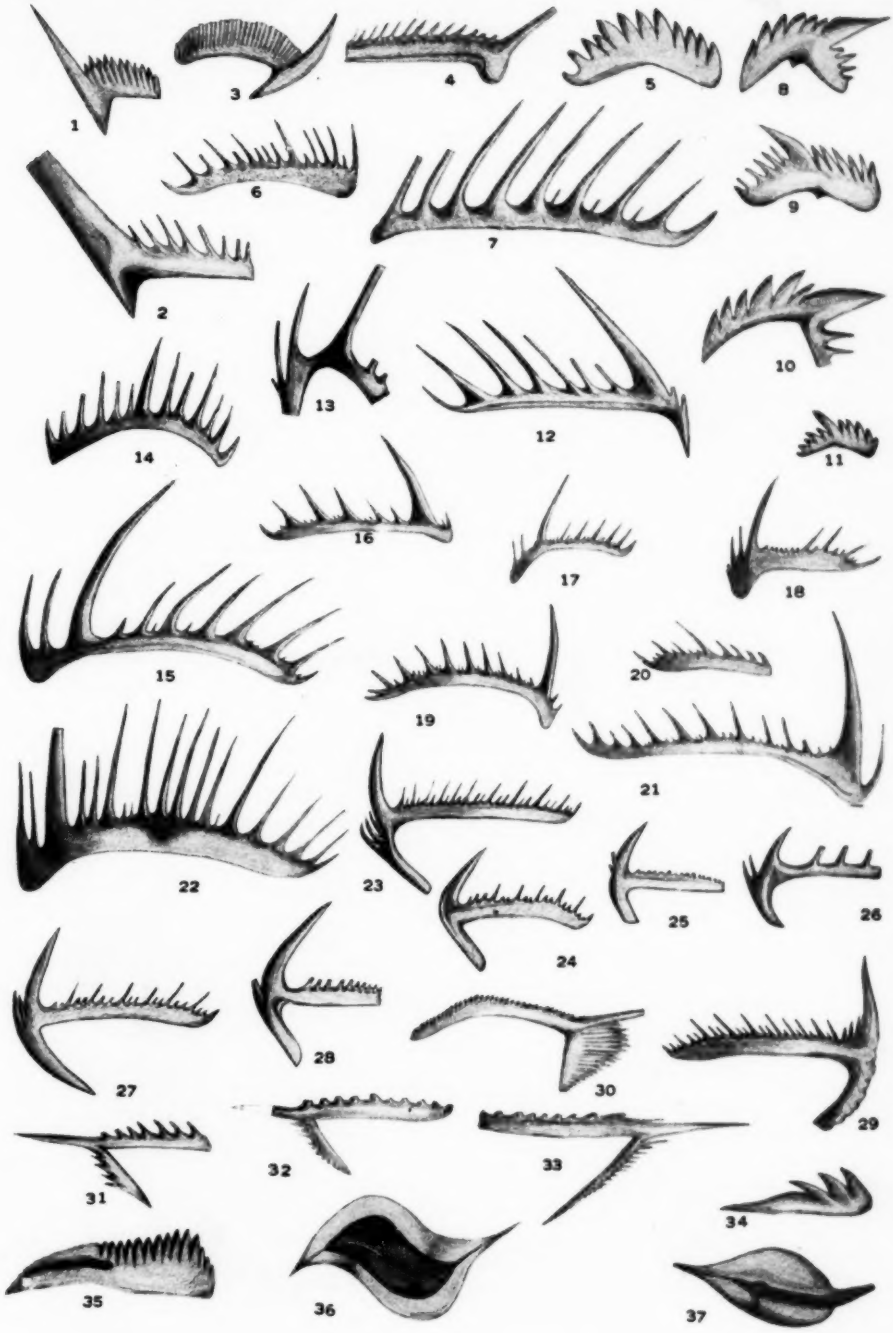
The bar is thick and slightly arched. The cusp and denticles, all long and slender, rise at right angles from the bar. The main cusp is

---

EXPLANATION OF PLATE 28

FIGS. 1—*Prioniodus alatoideus*, (×37).
2—*Prioniodus macrocornatus*. (×27)
3—*Prioniodus arcuatus*, (×37).
4—*Prioniodus obtusus*, (×27).
5—*Prioniodella curvata*, (×27).
6—*Prioniodella aciedentata*, (×27).
7—*Prioniodella megastylus*, (×27).
8—*Bryantodus angulatus*, (×37).
9—*Bryantodus equalis*, (×37).
10—*Bryantodus deltoideus*, (×37).
11—*Bryantodus subequalis*, (×37).
12—*Euprioniodina macrodentata*, (×27).
13—*Lonchodina angulata*, (×27).
14—*Lonchodina subarcuata*, (×27).
15—*Hindeodella curvidens*, (×27).
16—*Hindeodella crassidens*, (×27).
17—*Hindeodella subtilita*, (×27).
18—*Hindeodella pumilla*, (×27).
19—*Hindeodella subgracilis*, (×27).
20—*Hindeodella mediana*, (×27).
21—*Hindeodella petila*, (×27).
22—*Hindeodella macrodentata*, (×27).
23—*Hamulosodina tridens*, (×37).
24—*Hamulosodina simplex*, (×27).
25—*Hamulosodina parilis*, (×37).
26—*Hamulosodina perdentata*, (×37).
27—*Hamulosodina bidens*, (×37).
28—*Hamulosodina unica*, (×37).
29—*Hamulosodina nodosa*, (×37).
30—*Palmatodella inflexa*, (×27).
31—*Telumodina typicalis*, (×27).
32—*Telumodina deckeri*, (×27).
33—*Telumodina gracilis*, (×27).
34—*Polygnathus tridenticulata*, (×37).
35—*Polygnathus crassus*, (×27).
36—*Palmatolepis regularis*, (×27).
37—*Palmatolepis simplex*, (×27).

Note: Figures 36 and 37 should be turned 90° to the right.



Cooper, Woodford (Mississippian) Conodonts

much larger than the largest of the denticles. The denticles are irregular in size, some being nearly two times as long as others. Immediately behind the cusp are two small denticles, followed by the two largest ones on the bar. Following these are 10 denticles of irregular length, those nearest the end being nearly equal in length to those adjacent to the cusp. The front end of the cusp is deflected sharply, and carries two slender denticles of average length. At two places along the bar the main denticles are alternated by very much shorter ones.

Genus HAMULOSODINA Cooper, n. gen.

This new genus more closely resembles *Euprioniodina* than any other of the described genera. It differs from this genus in that the downward projection is much more developed and does not carry a denticulation along its entire length. In fact the development of the projection below the bar is equal to or greater than the main cusp, usually continuing the curvature of the cusp without interruption, giving the tooth a decided pick-like appearance. The denticles that appear in front of the cusp, if they are present, are confined to the area immediately adjacent to the end of the bar. The specific differences of several new species under this genus are determined by the number of denticles occurring in this place. *H. bidens* is the genotype.

HAMULOSODINA TRIDENS Cooper, n. sp.

Plate 28, figure 23

The bar is straight with eleven main denticles alternating with one or more smaller ones. The cusp is inclined slightly forward and somewhat curved; it is rather heavy and of about the same width for two-thirds of its length, after which it tapers rapidly to a point. The downward projection is of approximately the same length as the cusp, and has a blunt termination. In front of and at the base of the cusp is located three small upward projecting denticles which give the species its name.

HAMULOSODINA SIMPLEX Cooper, n. sp.

Plate 28, figure 24

The bar is short and somewhat curved, with six or more main denticles with two or more smaller ones between. The main cusp is broad at the base, gradually tapering to a point. The cusp, together with a downward projection of equal length, is extremely pick-like in appearance. Unlike most species of the genus, this form does not have

the small denticles in front of the cusp. The downward projection has the same sort of termination as *H. tridens*.

HAMULOSODINA PARILIS Cooper, n. sp.
Plate 28, figure 25

The bar is short and straight, with close-set denticles, which, though broken, appear to be of equal size. The cusp and downward projection are likewise short and thick, the cusp tapering to a point and the projection having a blunt end. Two small denticles are found in front of the cusp, located at a point higher up on the cusp than is usually found in other species.

HAMULOSODINA BIDENS Cooper, n. sp.
Plate 28, figure 27

The bar is slightly curved and of medium length, carrying a dentition similar to *H. tridens*. The cusp is of average size, but the projection below it is unusually long and heavy as compared with the rest of the tooth. This species is also distinguished by the sharp termination of the downward projection. Two small denticles are situated in front of, and at the base of the cusp. This species has been selected as the type for the genus.

HAMULOSODINA PERDENTATA Cooper, n. sp.
Plate 28, figure 26

The bar is thin with a few, somewhat large and discrete denticles, with no smaller ones between. The cusp and projection are short and thick near the bar, both tapering rapidly to a point. Two denticles are located in front of and rather low down on the cusp.

HAMULOSODINA UNICA Cooper, n. sp.
Plate 28, figure 28

Bar and projection strongly bowed as in *H. simplex* but with one rather large denticle in front. The bar is straight, of average thickness, and carries a number of closely arranged denticles which appear to be of equal size.

HAMULOSODINA NODOSA Cooper, n. sp.
Plate 28, figure 29

The bar is straight and relatively thick, carrying nine or more main denticles with one to two smaller ones between them. The denticles

are inclined somewhat sharply to the back. The cusp sits upright on the end of the bar, is relatively broad at the base, tapering to a point. The front side of the projection is somewhat scalloped or nodose, and there are no denticles in front, as in all other species except this and *H. simplex*.

Genus PALMATODELLA Ulrich and Bassler, 1926

PALMATODELLA INFLEXA Cooper, n. sp.

Plate 28, figure 30

Somewhat similar to *P. delicatula* Ulrich and Bassler, with respect to dentition and cusp. The bar, however, is thicker and decidedly bowed near its middle portion, hence its name.

Genus TELUMODINA Cooper, n. gen.

This new genus has somewhat the same general aspect as the *Euprioniodina* Ulrich and Bassler, especially to *E. perangulata*. However, this genus can not be readily confused with *Euprioniodina* as none of the three species listed under the new genus closely resemble any of the species described from the Mississippian, or the Devonian, for that matter. *Telumodina* is more fragile in every respect. The cusp is inclined forward to such an extent that it is in the same straight line as the axis of the bar. The downward projection, beginning at the base of the cusp, is inclined 45°-55° to the bar and carries a dentition along its front face. The result is a spear- or javelin-shaped tooth carrying a large number of barbs. *T. typicalis* is the genotype.

TELUMODINA TYPICALIS Cooper, n. sp.

Plate 28, figure 31

The bar is straight and slender, with fairly close-set, discrete denticles slightly inclined forward. The downward projection, inclined 50° to the bar is very similar to the bar in size and dentition. The projection is terminated by a long tapering point free of denticles. The cusp is slender, tapering to a very sharp point.

TELUMODINA DECKERI Cooper, n. sp.

Plate 28, figure 32

The bar is straight and slightly heavier than *T. typicalis*. The denticles on the bar are apparently of equal size, rather heavy and discrete, while those on the projection, which is inclined 55° to the bar, are smaller

and closer set than the others. The projection ends in a rapidly tapering point.

TELUMODINA GRACILIS COOPER, N. SP.
Plate 28, figure 33

The bar is rather heavy, ending in a slender tapering cusp. The denticles on the bar are slender and inclined sharply forward near the cusp becoming heavier and more upright toward the back. The projection which lies at an angle of 45° to the bar, is very long and slender and carries numerous closely arranged denticles. These denticles become shorter toward the end of the projection, and finally disappear altogether two-thirds the distance from the bar. The remaining third is very slender and tapers to a sharp point.

GENUS POLYGNATHUS ULRICH AND BASSLER, 1926

POLYGNATHUS TRIDENTICULATA COOPER, N. SP.
Plate 28, figure 34

The tooth is very small, with only three broad, tapering denticles on the anterior end, all of which are inclined backward. The remainder of the tooth is slender, ending in a sharp point.

POLYGNATHUS CRASSUS COOPER, N. SP.
Plate 28, figure 35

This species is similar to *P. pennatulus* Ulrich and Bassler, but in general more massive. Also the denticles are longer, and discrete in their upper half and fused in the lower half. The posterior portion of the tooth is not so curved as in *P. pennatulus*, though it carries the nodes on its upper surface as does the former species.

GENUS PALMATOLEPIS ULRICH AND BASSLER, 1926

PALMATOLEPIS REGULARIS COOPER, N. SP.
Plate 28, figure 36

This species is characterized by its extremely regular outline, the sides of which are formed by two "ogee" curves. The leaf-like appearance is further accentuated by the carina or ridge bisecting the tooth from base to top. The tooth is without ornamentation except fine concentric lines and the darkened center, resulting in a light colored rim around the specimen. The opposite surface is covered by numerous closely spaced tubercles without definite arrangement.

PALMATOLEPIS SIMPLEX COOPER, N. SP.
Plate 28, figure 37

The outline of this species is lanceolate, the tip being very sharp and narrow. The base or "stem" is formed by the continuation of the carina. This ridge narrows toward the opposite end, except near the center of the specimen where there is a pronounced bulge. The species is devoid of ornamentation.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 244-252, PL. 29, SEPTEMBER, 1931

CONODONTS FROM THE FORT SCOTT LIMESTONE OF MISSOURI

FRANK H. GUNNELL
University of Missouri, Columbia, Missouri

ABSTRACT

The Devonian and Carboniferous formations of Missouri and Kansas contain an abundant conodont fauna. From the Fort Scott limestone the writer describes 3 new genera and several new species.

Reconnaissance collecting and study of conodonts from Missouri, Kansas, and Oklahoma has shown that they are abundant in the Snyder Creek shale of the Devonian, the Grassy Creek shale, Louisiana limestone, Glen Park formation, Hannibal sandstone, Sylamore sandstone, Bushberg sandstone, and Fern Glen formation of the Mississippian. In the Pennsylvanian, conodonts occur abundantly in the Cherokee, Henrietta, Kansas City, Lansing, Shawnee and Wabaunsee formations, and channel sandstone of uncertain Pennsylvanian age. These minute teeth and scales are also found in the Permian of Kansas.

The types of sediments which the writer has found to contain conodonts are in order of abundance shale, sandstone, conglomerate, and limestone. A three pound sample from a shale member of one Pennsylvanian formation contained twelve genera. Although the great variety of forms from this sample is probably not a true indication of conodont distribution in Carboniferous formations, it does not exaggerate their abundance in some members.

Undoubtedly conodonts have large geographic and stratigraphic distribution. It is probably because of their microscopic size and most abundant occurrence in sediments devoid of other fossils that paleontologists have neglected them.

Pennsylvanian conodonts consist of minute plates, teeth, and scales most of which are brown in color and show a pearly luster. This assemblage together with the presence of forms which resemble small sharks' teeth is evidence that conodonts are fishes.

The evolution of different species in the Mississippian and Pennsylvanian periods was more or less gradational, yet specific differences are numerous.

Conodonts are of geologic importance for correlation purposes in that they come from free swimming fishes which afforded rapid distribution of each species. Many of the species are of small stratigraphic range and rather abundant within that range.

From the Fort Scott member of the Henrietta formation the writer has identified 21 species. Many of the species which occur in the Fort Scott are also found in the conglomeratic part of the channel deposits in the vicinity of Columbia, Missouri. This seems to indicate that the channel sandstones near Columbia began to form during Fort Scott time.[1] When the present investigations are completed their results should, aside from correlation of formations from well cuttings, enable the stratigrapher to make accurate correlations of the channel sandstones, coal beds with marine shales, and those Carboniferous shales which are practically barren of other fossils.

FORT SCOTT CONODONTS

The conodonts described in this paper were collected from the shaly middle portion of the Fort Scott limestone, member of the Henrietta formation, lower Middle Pennsylvanian. The collecting locality is an exposure in the highway cut near the river bluff at Lexington, Missouri.

GENUS ACODUS PANDER, 1856

ACODUS ? CIRCULATUS GUNNELL, N. SP.

Plate 29, figure 1

Outline of basal cross-section circular. Height equal to twice basal width. Sides slightly expanding from base to summit. Tooth gently arched. Basal four-fifths appears frosted, and summit portion translucent.

The aboral surface of the holotype is broken but specimens of a related species have concave aboral surfaces. The translucent upper portion of the tooth represents a structural feature which the writer is unable to explain. Although there is no carina either in this species or *A. simplex*, the writer refers them to *Acodus* because of the resemblance to *Acodus crassus*.

[1]The possibility of redeposition of conodont material in the channel sandstones should not be overlooked. If conodonts are transported very far they are likely to be somewhat broken and worn but otherwise they may show little effect of transportation.—Editor.

ACODUS ? SIMPLEX GUNNELL, N. SP.
Plate 29, figure 2

Outline of basal cross-section subcircular. Height four times basal width. Tooth symmetrical, projecting upright at right angles to basal plane, and flaring at base. Aboral surface gently concave.

This species is more slender than *Acodus ? circulatus*.

GENUS PRIONIODUS PANDER, 1850

PRIONIODUS TRIDENTATUS GUNNELL, N. SP.
Plate 29, figure 3

Tooth long, flaring at base, and curving strongly slightly above base. Denticles small, distinct from tooth, joined to main cusp only on one side of their greatest diameter and occurring opposite each other on extremities of greatest diameter of base. Basal outline subelliptical. Denticle bases extending slightly below base of main cusp. Tooth cross-section subelliptical near mid-height. Aboral surface strongly concave.

This species differs from *P. lexingtonensis* and *P. missouriensis* in its subelliptical cross-section.

PRIONIODUS LEXINGTONENSIS GUNNELL, N. SP.
Plate 29, figure 4

Tooth straight except for sharp curve at one-fifth of the total height above base. Outline of base subtriangular with one denticle opposite each of the two longer sides. Curvature of tooth in line with greatest altitude of triangular base. Cross-section sub-triangular near mid-height. Aboral surface strongly concave. Height four times width at base.

The height-width ratio of *P. missouriensis* is greater than that of this species.

PRIONIODUS SUBACODUS GUNNELL, N. SP.
Plate 29, figure 5

Tooth robust, gently curving throughout total length, flaring slightly at base. Node, two times as long as wide, projecting downward from basal margin of tooth. Small ridge on one side of tooth originating at node and extending to tip. Cross-section subcircular. Aboral surface gently concave.

The distinguishing characteristic of this species is a linear ridge on one side of the tooth. The generic reference to *Prioniodus* rather than *Acodus* is because of the projecting node which is not found on *Acodus*.

PRIONIODUS CLARKI GUNNELL, N. SP.
Plate 29, figure 8

Tooth gently curving a short distance above base. Base outline subtriangular with two denticles on extremity near smallest angle, opposite direction of tooth curvature; one denticle on angle of intermediate size; no denticle on largest angle. Tooth cross-section subtriangular throughout. Aboral surface gently concave with rounding margins.

The angularity of the cross-section distinguishes this species from *P. tridentatus*.

PRIONIODUS MISSOURIENSIS GUNNELL, N. SP.
Plate 29, figure 9

Tooth long, uniformly tapering toward fine point, sharply curved at about one-third of the total height above base. Outline of cross-section subcircular near mid-height. Outline of base subtriangular with small blade-like node on each corner. Aboral surface strongly concave. Tooth curvature in line with greatest altitude of triangular base outline.

The greater height-width ratio distinguishes this species from *P. lexingtonensis*.

PRIONIODUS CONJUNCTUS GUNNELL, N. SP.
Plate 29, figure 7

Tooth long, almost straight, and flaring at base. One edge forming almost straight line from base to summit, opposite shorter, and flaring outward near base. Slender denticle extending confluently along side of tooth from base to two-thirds of the total height of tooth. Outline of base subelliptical. Tooth cross-section subcircular near mid-height. Aboral surface slightly concave.

The single confluent denticle distinguishes this species from *P. subacodus*, the most closely related species.

PRIONIODUS BIDENTATUS GUNNELL, N. SP.
Plate 29, figure 6

Bar strongly arching with main cusp at one extremity, and five small denticles along rest of oral surface. Ridge crossing bar between large cusp and adjoining denticle. Cross-section of large cusp subrectangular; small denticles subelliptical in cross-section, and uniform in size. Denticles and cusp curving inward (convex side). Main cusp occupies space equal to that of two denticles.

There are right and left specimens of this species. On the figured specimen the bar is complete, and has five broken denticles.

GENUS SCOLOPODUS PANDER, 1856

SCOLOPODUS ELLIPTICUS GUNNELL, N. SP.

Plate 29, figure 10

Single long tooth tapering gradually from base to summit, and pointing obliquely from basal plane. Cross-section at right angles to height subelliptical. Sides with striations, some beginning at basal margins and extending to summit, others coalescing about one-third of the height above base. Aboral surface flat to slightly concave.

GENUS LONCHODUS PANDER, 1856

LONCHODUS SIMPLEX PANDER

Plate 1, figures 10, 11

Lonchodus simplex. PANDER, *1856*, Monographie der fossilen Fische des Silurischen Systems der russisch—baltischen Gouvernements, p. 31, tab. 2A, figs. 2, 3, 5, 6. ROUNDY, *1926*, U. S. Geol. Survey, Prof. Paper 146, p. 15, pl. 3, figs. 1-5.

The height to length ratio is slightly greater in the specimens figured, than those from Russia described by Pander.

LONCHODUS CONFLUENS GUNNELL, N. SP.

Plate 29, figure 17

Bar straight with oblique denticles on upper surface. Denticles laterally flat; confluent at bar; anterior and posterior edges blade-like.

The blade-like denticles distinguish this species from *L. simplex*.

GENUS LONCHODINA ULRICH AND BASSLER, 1926

LONCHODINA SP.

Plate 29, figures 15, 16

LONCHODINA ? PECULIARIS GUNNELL, N. SP.

Plate 29, figure 18

Bar strong, arching, bearing denticles and central cusp on upper surface, flaring at base below central cusp. Central cusp large and arching, thick base forming summit portion of bar. Aboral surface concave opposite central cusp and flat opposite denticles.

The bar is broken from each side of the main cusp.

GENUS PRIONIODINA ULRICH AND BASSLER, 1926

PRIONIODINA ? SP.

Plate 29, figure 27

This specimen is broken and a specific description will be deferred until more complete specimens are obtained. The specimen figured has an arching bar, laterally compressed, and bearing denticles along upper surface. The bar is almost straight on each side of the arch.

GENUS HINDEODELLA ULRICH AND BASSLER, 1926

HINDEODELLA SP.

Plate 29, figures 11, 12

Although the anterior and posterior ends of the writer's specimens are broken the species is easily distinguished from the Mississippian species by its small size.

GENUS GNATHODUS PANDER, 1856

GNATHODUS ROUNDYI GUNNELL, N. SP.

Plate 29, figures 19, 20

General form spear-shaped. Oral surface with straight row of denticles extending throughout length of plate and bar. One oral margin of plate with row of denticles, opposite oral margin with single denticle.

Size and shape of denticles uniform. Aboral surface of plate concave. Carina submedian, and continuous with bar.

The single denticle on one oral margin of the plate with a row of denticles on the opposite oral margin distinguishes this species from *G. mosquensis*, which has a row of denticles on each oral margin.

GENUS IDIOGNATHODUS GUNNELL, N. GEN.

Plate subsymmetrically lanceolate to claviform, and connected posteriorly with denticle-bearing bar. Oral surface of plate flat to subconvex bearing nodes or ridges. Aboral surface of plate concave with longitudinal groove separating two subequal areas. The genotype is *I. claviformis* n. sp.

IDIOGNATHODUS CLAVIFORMIS GUNNELL, N. SP.

Plate 29, figures 21, 22

Posterior oral surface of plate with irregular arrangement of nodes and ridges; rest of oral surface with six parallel transverse ridges. Margins of oral surface rounding. Anterior end blunt. Plate length to

width ratio 8 to 5. Bar with denticles on upper surface, joining posterior oral surface of plate.

In the majority of specimens the bar is broken from the plate.

IDIOGNATHODUS DELICATUS GUNNELL, N. SP.
Plate 29, figures 23, 24, 25

General shape lanceolate. Plate narrow, longitudinally arching; oral surface transversely flat with three rows of nodes on posterior portion almost at right angles to six transverse parallel ridges on anterior portion. Sides of plate vertical except for small flange on basal portion. Length to width ratio of plate 3 to 1. Bar straight, length equal to length of plate.

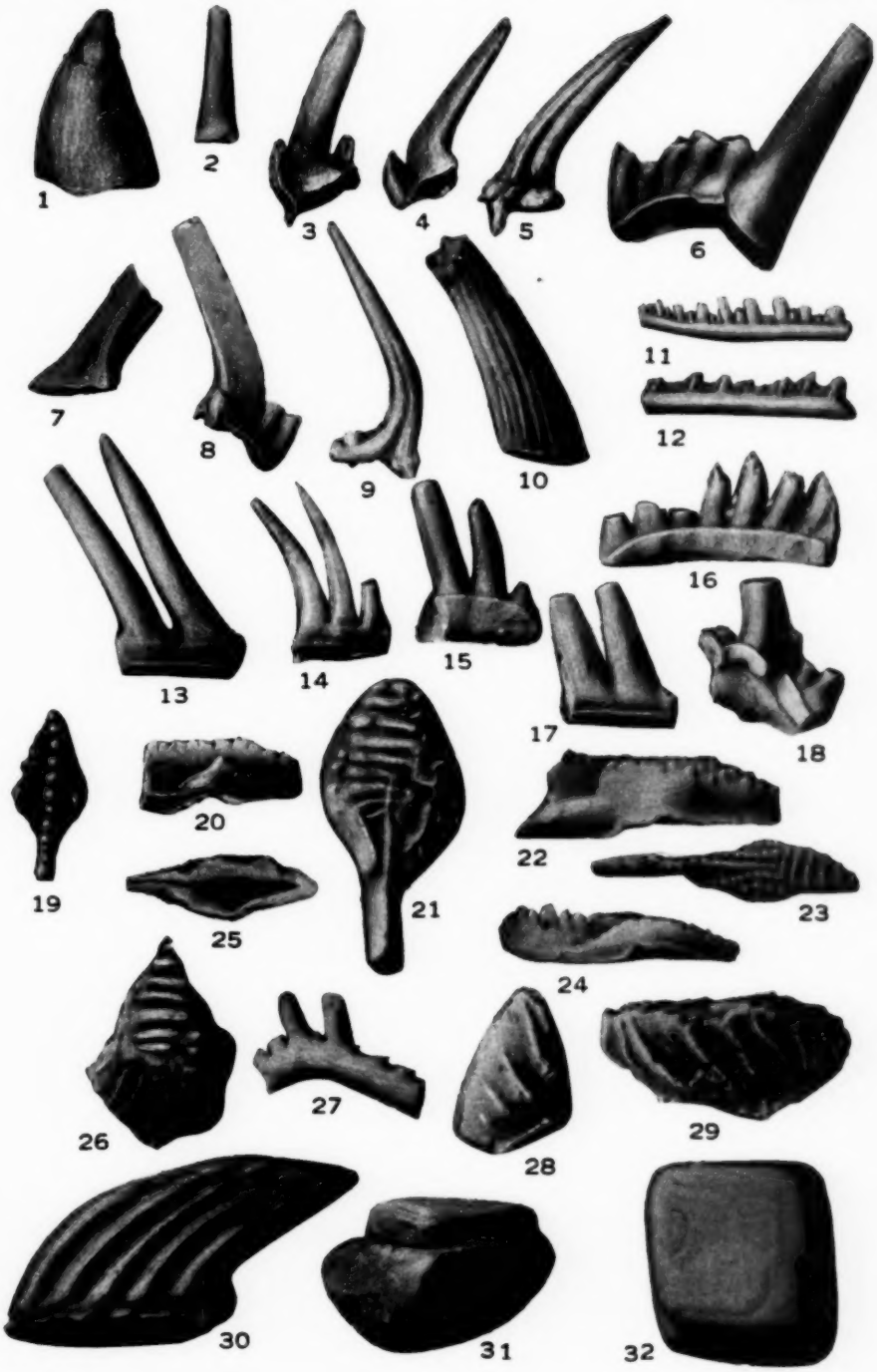
This species is characterized by a large length to width ratio of the plate.

IDIOGNATHODUS ARCUATUS GUNNELL, N. SP.
Plate 29, figure 26

General shape lanceolate. Plate arching longitudinally; oral surface transversely flat except for rounding margins, sinuous posteriorly, with six transverse parallel ridges on anterior portion; sides extending outward aborally to form flanges. Greatest aboral width one-fifth greater

EXPLANATION OF PLATE 29
Magnification × 35

FIGS. 1—*Acodus ? circulatus* Gunnell, n. sp. Side view.
2—*Acodus ? simplex* Gunnell, n. sp. Side view.
3—*Prioniodus tridentatus* Gunnell, n. sp. Side view.
4—*Prioniodus lexingtonensis* Gunnell, n. sp. Side view.
5—*Prioniodus subacodus* Gunnell, n. sp. Side view.
6—*Prioniodus bidentatus* Gunnell, n. sp. Side view.
7—*Prioniodus conjunctus* Gunnell, n. sp. Side view.
8—*Prioniodus clarki* Gunnell, n. sp. Side view.
9—*Prioniodus missouriensis* Gunnell, n. sp. Side view.
10—*Scolopodus ellipticus* Gunnell, n. sp. Side view.
11, 12—*Hindeodella* sp. Side view.
13, 14—*Lonchodus simplex* Pander. Side view.
15, 16—*Lonchodina* sp. Side view.
17—*Lonchodus confluens* Gunnell, n. sp. Side view.
18—*Lonchodina ? peculiaris* Gunnell, n. sp. Side view.
19, 20—*Gnathodus roundyi* Gunnell, n. sp. Oral view, side view.
21, 22—*Idiognathodus claviformis* Gunnell, n. sp. Oral view, side view.
23, 24, 25—*Idiognathodus delicatus* Gunnell, n. sp. Oral, side and aboral views.
26—*Idiognathodus arcuatus* Gunnell, n. sp. Oral view.
27—*Prioniodina ?* sp. Side view.
28—*Fortscottella seniserrata* Gunnell, n. sp. Side view.
29—*Fortscottella serrata* Gunnell, n. sp. Oblique side view.
30—*Fortscottella gigantea* Gunnell, n. sp. Side view.
31, 32—*Holmesella quadrata* Gunnell, n. sp. Side view, oral view.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

than largest oral width. Plate with 4 to 3 length to width ratio, anterior end sharp.

The arched, pointed plate distinguishes this species from *I. claviformis*. The bar is broken from the figured specimen.

Genus FORTSCOTTELLA Gunnell, n. gen.

Basal outline subelliptical to subcircular. Transverse cross-section semi-subelliptical to subtriangular. Sides with obliquely pointing parallel ridges. Median ridge beginning at basal anterior margin and extending to posterior margin. The genotype is *F. gigantea* n. sp.

FORTSCOTTELLA GIGANTEA Gunnell, n. sp.

Plate 29, figure 30

Basal outline subelliptical. Transverse cross-section subtriangular. Tooth almost bilaterally symmetrical from anterior edge to posterior margin. Outline in plane of bilateral symmetry trapezoidal. Each side with 5 rounding parallel ridges obliquely arching from base toward median ridge. Upper margin of sides form sharp arching median ridge from anterior basal margin to three-sided obliquely protruding, sharp posterior end. Aboral face slightly concave.

The large size, and obliquely protruding point of this species distinguish it from *F. serrata* and *F. semiserrata*.

FORTSCOTTELLA SERRATA Gunnell, n. sp.

Plate 29, figure 29

Basal outline subelliptical. Transverse cross-section semi-subelliptical. Each side with nine angular oblique parallel ridges. Ridges successively longer from anterior margin to two-thirds total length toward posterior and thence decreasing posteriorly. Median ridge sharp, serrate laterally, and arching to basal margins anteriorly and posteriorly. Aboral surface flat with margins extending slightly beyond summit of ridges.

The lateral extension of the base may prove to be a generic character, when more knowledge is obtained of the genus.

FORTSCOTTELLA SEMISERRATA Gunnell, n. sp.

Plate 29, figure 28

Basal outline subelliptical. Longitudinal, and transverse cross-sections subtriangular. Tooth almost bilaterally symmetrical from anterior edge to posterior margin. Each side of tooth with four angular

parallel ridges, originating at sharp anterior edge and extending posterior obliquely toward basal margins. Basal margins with small lateral ridge. Aboral surface slightly convex. Height of tooth one and a half times the length, and three times the width.

The greater height to length ratio distinguishes this species from *F. gigantea* and *F. serrata*.

Genus HOLMESELLA Gunnell, n. gen.

Outline trapezoidal to quadrangular. Base large, subpyramidal to subconvex, and supporting block-like tooth. Oral surface flat, or bearing ridges. Tooth outline differs slightly from outline of base. Upper part of tooth sharply set off from base. The genotype is *H. quadrata* n. sp.

HOLMESELLA QUADRATA Gunnell, n. sp.

Plate 29, figures 31, 32

Outline trapezoidal. Length equal to width. Base robust, strongly convex, subpyramidal, and supporting block-like tooth. Oral surface flat. Outline of tooth block-like, upper portion smaller than that of base. Upper portion of tooth set upon flat shoulder of base forming demarcation on four sides between base and upper portion of tooth. Sides of upper part of tooth vertical.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 253-259, PL. 30, 1 TEXT FIG., SEPTEMBER, 1931

PRIMITIVE FUSULINIDS OF THE MID-CONTINENT REGION

JOHN W. SKINNER
Indian Territory Illuminating Oil Company, Bartlesville, Oklahoma

ABSTRACT

The presence of the genus *Fusiella* on this continent is reported for the first time, a minor change in the wall structure of the genus *Fusulina* is pointed out, and four new species, representing four genera, are described.

INTRODUCTION

Recently Lee and Chen[1] erected the fusulinid genus *Fusiella* to embrace two species: *Fusiella typica* and *F. paradoxa*, the former being the genotype. The most important feature of this genus is the possession of a very primitive type of wall structure. This recalled to mind a minute species from Mason County, Texas, which, after a very perfunctory examination, had been assigned by the writer to the genus *Fusulinella* s. s. The Texas specimens were subjected to a careful scrutiny and were found to exhibit all the characters of *Fusiella* except that they are approximately twice the size of the Chinese species.

Some time ago, the writer chanced to observe that the wall structure in a certain sagittal section of *Fusulina distenta* apparently did not conform exactly with accepted ideas on this structure. The diaphanotheca, instead of extending only down the back of each septum, was found to extend down the forward side as well (Fig. 1A). Furthermore, in some instances, a coat of secondary material may be observed between the tectum of the septum and the diaphanotheca. Subsequent examination showed that all the McCoy[1] fusulinids display this character, as do *Fusulina leei* n. sp. and *Wedekindia henbesti* n. sp. of the present paper.

Some interesting conclusions concerning the formation of the wall may be drawn from these observations. It is obvious that the tectum and the diaphanotheca are not formed simultaneously, and that the tectum is formed first. This latter is shown by the fact that in some cases there is a secondary deposit formed on that portion of the tectum which

[1]Lee, J. S., Chen, S., and Chu, S.: Huanglung Limestone and its Fauna, Mem. Nat. Res. Inst. Geol., No. IX, pp. 107-09, Pl. II, fig. 1; Pl. VI, figs. 1-8, 1930.

[2]Roth, R., and Skinner, J.: Fauna of the McCoy Formation, Pennsylvanian, of Colorado, Jour. Pal., Vol. 4, No. 4, December, 1930.

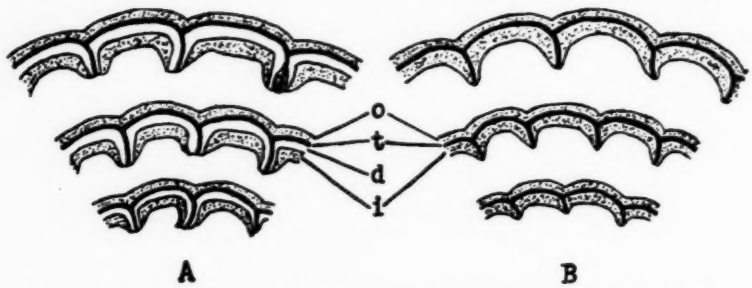


FIG. 1.—Diagram showing the wall structure of *Fusulina* (A) and *Fusiella* (B); *o*, outer secondary deposit; *t*, tectum; *d*, diaphanotheca; *i*, inner secondary deposit.

is inbended to produce a septum, and the diaphanotheca is deposited upon this secondary layer. Next, a layer of secondary material is formed upon the surface of the diaphanotheca, and finally, when the exterior of the wall is covered by the succeeding whorl, still another layer is deposited upon the outside of the tectum, or, in other words, upon the floor of the chambers of the succeeding whorl. It is probable that the inner secondary deposit of any whorl is formed simultaneously with the outer deposit of the preceding volution. That is to say, this material is deposited simultaneously upon the roof and floor of any chamber. This belief is borne out by the fact that in a large number of well preserved specimens in which the tectum of the ultimate whorl is intact, in no case has the writer observed any trace of secondary material upon the exterior part of the test. It has been suggested by some workers that this may be due to removal during or after fossilization, but the writer finds it difficult to imagine a coincidence in which hundreds of individuals might have such a deposit entirely removed without injury to the thin and doubtless fragile tectum. Further, in the last eighth of a whorl, the deposit upon the *interior* of the test can be seen to thin rapidly until, in the final chamber, it is entirely lacking. If we assume an agency to have removed a deposit from the exterior of the test, we must also credit this same agency with removing the secondary material from a portion of the interior as well,—and all this without injury to the tectum or diaphanotheca. The writer believes that such an assumption is absurd. The foregoing argument is presented for the purpose of demonstrating the secondary nature of the outer and inner layers of the wall, this point having been questioned recently by several workers.

The writer has seen a number of specimens of *Fusulina* in which the wall was crossed by numerous dark lines similar in appearance to the

alveolar structure of *Triticites*. These lines, however, continue uninterruptedly across the entire thickness of the wall, traversing the tectum and both secondary deposits as well as the diaphanotheca. Since the deposition of the outer secondary layer is approximately one volution behind that of the rest of the wall, and since the lines are observed to traverse this layer, it is obvious that these lines also are of secondary origin. Consequently they can in no measure be regarded as analogous to the alveoli of *Triticites*, since the latter consist of hollow prisms or tubes bounded by thin lamellae of testaceous material pendant from and continuous with the tectum, and are of undoubted primary origin.

DESCRIPTION OF SPECIES

FAMILY FUSULINIDAE MÖLLER, 1877

SUBFAMILY FUSULININAE (STAFF AND WEDEKIND)

GENUS FUSIELLA LEE AND CHEN, 1930

FUSIELLA PRIMAEVA SKINNER, N. SP.

Plate 30, figures 7-9, 11

Test small, fusiform, lateral slopes slightly convex, and ends bluntly rounded giving an ovate outline. Mature specimens possess 5½ to 6 whorls and vary in length from 2.8 to 3.32 mm., and in width from 1.22 to 1.48 mm. Form ratio ranges from 1:2.22 to 1:2.4.

Septa are nearly plane, being very gently folded near the poles. No pores have been observed. Septal count for three typical specimens follows:

Whorl	1	2	3	4	5	6
A	10	12	14	15	17	17
B	8	11	12	17	18	inc.
C	8	10	12	15	17	inc.

The tunnel is quite wide, the angle ranging from 40 to 50 degrees and being usually about 44 degrees. Initial chamber small, its diameter varying from 86 to 125 microns.

Chomata are well developed, especially considering the thinness of the wall or spirotheca which has a thickness of about 35 microns at the end of the fourth whorl. The wall is composed of three layers: a comparatively thick outer one of structureless, translucent material; a thin, opaque layer which is evidently the tectum; and an inner structureless, translucent layer. The first and last apparently correspond to the coats of secondary material found in *Fusulina*, *Fusulinella*, and *Wedekindia*.

There is no trace of a diaphanotheca or keriotheca, or anything that might be analogous to them.

It is on the basis of this primitive type of wall structure, together with an endothyroid nucleoconch, that Lee and Chen have separated this genus from *Fusulinella*, to which it bears a strong superficial resemblance. The present species does not possess an oblique nucleoconch except in a few infrequent cases. This is the third species of this interesting group to be reported, and is at present the only known American representative of the genus.

Horizon and locality. *Fusiella primaeva* occurs in abundance in a limestone outcropping at stream level at a point where the road crosses the Llano River southeast of London, Texas. This is the second crossing 15 miles west and 9 miles south of the town of Mason, Mason County, Texas. This horizon has been tentatively correlated by Roth, who collected the material, as being equivalent to a part of the Bend group, probably the upper part of the Marble Falls limestone. Associated with it are enormous specimens of *Chaetetes*. Holotype, U. S. National Museum, No. 84624.

Genus SCHUBERTELLA Staff and Wedekind, 1910

SCHUBERTELLA GALLOWAYI Skinner, n. sp.

Plate 30, figures 1, 5, 5a

Test minute, sub-globular, nucleoconch usually being coiled about an axis oblique to that of the outer whorls. Fully grown individuals possess 3½ to 4½ whorls, the first 1½ comprising the nucleoconch. Length varies from 0.65 to 0.95 mm., and width from 0.43 to 0.69 mm. Form ratio ranges from 1:1.29 to 1:1.37.

Septa nearly straight, being slightly folded in the region of the poles. No septal pores have been observed. Septal count for two representative specimens follow:

Whorl	1	2	3	4
A	10	16	18	19
B	10	15	16	inc.

Chomata strongly developed, forming low, broad ridges on either side of the narrow tunnel, which has an angle of 15 to 17 degrees. Proloculum small, having a diameter of 106 to 132 microns.

The wall, which measures about 35 microns at the end of the third whorl, exhibits the same structure as *Fusiella*. *Schubertella* may be distinguished from *Fusiella* by the shape of the test and the nature of the

coiling. The relation between the two genera is analogous to that obtaining between *Staffella* and *Fusulinella*. In regard to this relationship, Lee and Chen[1] say, "In *Fusiella* there is an extremely thin tectum forming the middle layer of the otherwise uniform wall. No trace of such a structural element can be detected in the wall of *Schubertella*. Only in doubtful cases the wall seems to become more opaque toward its outermost margin. The middle layer of tectum in *Fusiella* is however often blurred or even obliterated. Under such circumstances the generic distinction can still be recognized through the type of coiling and the general shape of the test. It is a general rule as far as our observations go, that in *Fusiella* the whorls are far more compactly coiled and the test much more elongated than in *Schubertella*."

The writer's observations on the wall structure of *Schubertella* do not agree with those just quoted, but the Chinese specimens were admittedly poorly preserved, while those under consideration at present are in a splendid state of preservation.

In view of the fact that in the past subfamilies have been differentiated chiefly on the basis of wall structure, the writer deems it both logical and natural to separate *Schubertella* and *Fusiella* as a new subfamily. However, since the literature concerning this family of foraminifera is already so complicated and contradictory, and since comparatively little is known as yet about these primitive genera, the writer hesitates to take such a step which might only add to the confusion which already exists in the literature of the *Fusulinidae*. However, should future research show such a separation to be desirable, the logical name for such a group would be *Schubertellinae*.

This species, which is named in honor of Dr. J. J. Galloway, occurs rather abundantly in a marl immediately overlying the Bluejacket sandstone in the CSL of Sec. 7, T. 21 N., R. 18 E., Oklahoma. Holotype, U. S. National Museum, No. 84623.

Genus FUSULINA Fischer, 1837

FUSULINA LEEI Skinner, n. sp.

Plate 30, figures 4, 6

Test small, slender, fusiform with ends bluntly to acutely pointed. Mature individuals have 7½ volutions and vary in length from 4.82 to 5.3 mm., and in width from 1.47 to 1.83 mm. Form ratio varies from 1:2.89 to 1:3.12.

[1] *Op. cit.*, p. 110.

Septa evenly folded from pole to pole. Septal pores abundant, first appearing in the sixth whorl. Septal count for two average specimens is:

Whorl	1	2	3	4	5	6	7
A	13	14	18	21	23	24	26
B	13	17	20	23	27	28	31

Chomata strongly developed and prominent. Tunnel rather wide for this genus, the angle being 27 to 32 degrees. Proloculum small, its diameter ranging from 86 to 139 microns. Measurements of the wall taken at the end of the fifth whorl are as follows: outer secondary deposit, 13.5 microns; tectum, 4.9 microns; diaphanotheca, 10.4 microns; inner secondary deposit, 14.8 microns.

Fusulina leei bears a remarkable superficial resemblance to *F. cylindrica*, but the differences are apparent at once if we tabulate their respective measurements as follows:

	Maximum Length	Maximum Width	Diameter Proloculum	Septal Count
F. cylindrica[1]	6.4 mm.	1.6 mm.	130-280 microns	10-18-24-32-36
F. leei	5.3 mm.	1.83 mm.	86-139 microns	13-14-18-21-23-24

[1]Measurements for *F. cylindrica* are compiled from the works of several authors, notably Schellwien and Lee.

F. leei also bears a resemblance to *F. hartvillensis*, but is nearly twice as large as the latter. This species is named in honor of Dr. J. S. Lee.

F. leei is found in the same horizon and locality as *Schubertella gallowayi*. Holotype, U. S. National Museum, No. 84621.

EXPLANATION OF PLATE 30

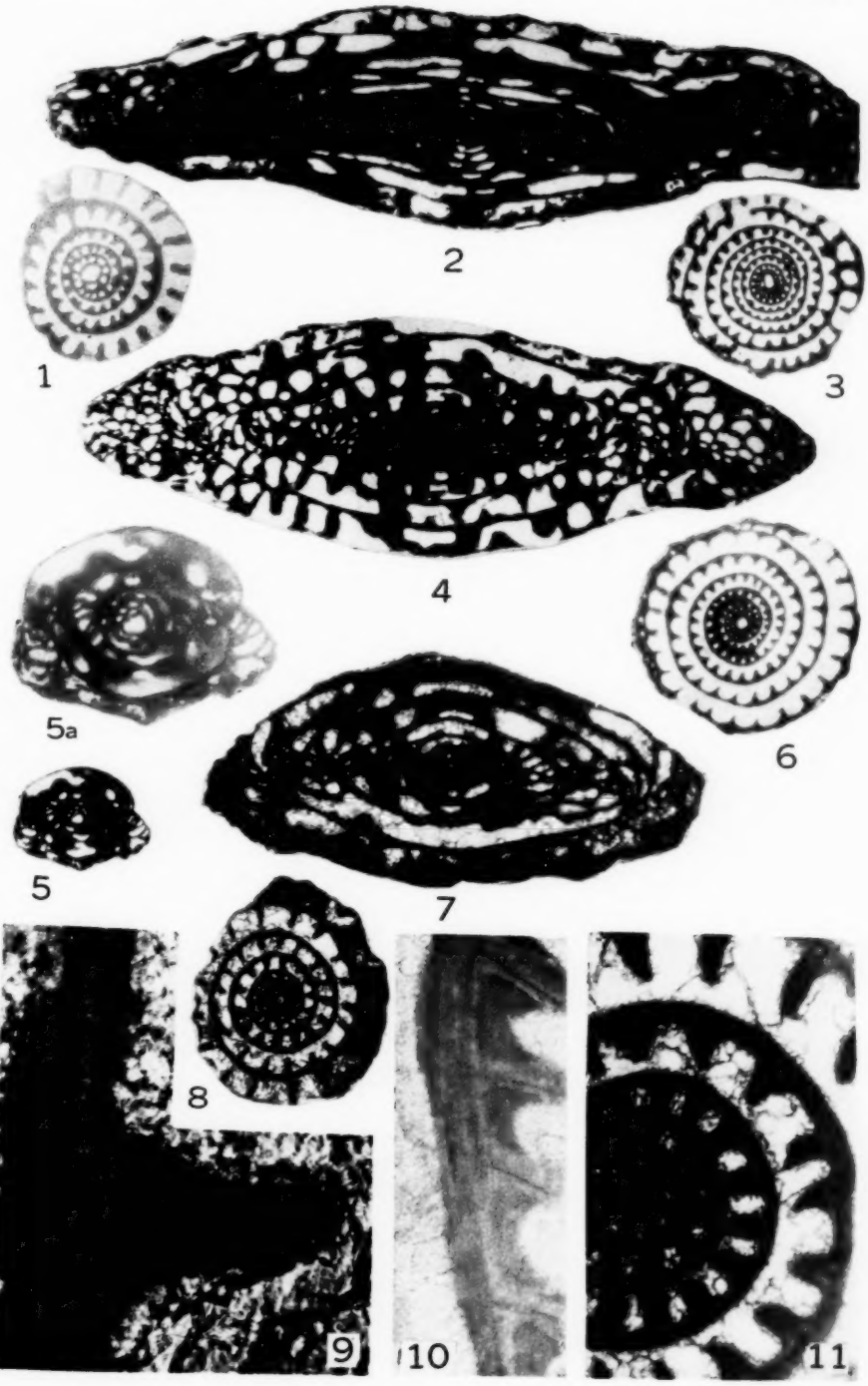
FIGS. 1, 5, 5a—*Schubertella gallowayi* Skinner, n. sp. 1, Sagittal section, (×40). 5, Axial section of the holotype, (×22). 5a, Same as figure 5, (×40).

2, 3—*Wedekindia henbesti* Skinner, n. sp. 2, Axial section of the holotype, (×22). 3, Sagittal section, (×22).

4, 6—*Fusulina leei* Skinner, n. sp. 4, Axial section of the holotype, (×22). 6, Sagittal section, (×22).

7-9, 11—*Fusiella primaeva* Skinner, n. sp. 7, Axial section, (× 22). 8, Sagittal section, (×22). 9, Part of the specimen shown in figure 11, (×380). 11, Part of a slightly excentric section showing the wall structure of the genus *Fusiella*, (× 80).

10—*Fusulina rockymontana*. Part of a sagittal section showing the diaphanotheca extending down both sides of the septa, (×190).



Skinner, Primitive Fusulinids

GENUS WEDEKINDIA DUNBAR AND HENBEST, 1930

WEDEKINDIA HENBESTI SKINNER, N. SP.

Plate 30, figures 2, 3

Test small, slender, tapering slowly to acutely pointed ends. Mature specimens have 10 to 10½ whorls, and vary in length from 5.13 to 5.37 mm., and in width from 1.33 to 1.39 mm. Form ratio ranges from 1:3.7 to 1:4.

Septa plane except at the poles where they are slightly folded. Septal pores have been observed, but they are neither coarse nor abundant. Septal count for two typical specimens is:

Whorl	1	2	3	4	5	6	7	8
A	11	15	16	18	21	24	23	25
B	9	13	16	19	19	21	20	inc.

Chomata well defined but not prominent. Tunnel fairly wide, the angle being 27 to 29 degrees. Proloculum minute and usually ovoid, measurements for two average specimens being 73 by 98 microns, and 71 by 84 microns. Wall extremely thin; measurements at the end of the fifth whorl are as follows: outer secondary deposit, 6.1 microns; tectum, 3 microns; diaphanotheca, 6.1 microns; inner secondary deposit, 4.9 to 10.4 microns.

Wedekindia henbesti is closely related to *W. euthusepta*, and there are a number of similarities. However, there are certain constant differences which serve to distinguish one species from the other. *W. euthusepta* has a smaller proloculum and is consistently smaller at the end of any given number of whorls. At the end of the seventh whorl it has a length of 2.78 mm. as compared to 3.21 mm. for the same whorl in *W. henbesti*. At the end of the eighth whorl, the former has a length of 3.29 mm. while the latter, for only 7½ whorls, has a minimum length of 3.73 mm. At the end of the ninth whorl *W. euthusepta* has a length of 4.02 mm. as compared to 4.49 mm. in *W. henbesti* for the same stage of growth. The tunnel angle is somewhat smaller in *W. euthusepta*, being about 20 degrees, while the deposit of secondary material in the axial zone is notably heavier than in the present species. All these characters taken together make it unlikely that the two species will ever be difficult to separate. The measurements for *W. euthusepta* are taken from Henbest's original description.[1]

W. henbesti occurs fairly abundantly associated with *Schubertella gallowayi* and *Fusulina leei* at the horizon and locality already given. Holotype, U. S. National Museum, No. 84622.

[1]Henbest, L. G., Fusulinellas from the Stonefort Limestone Member of the Tradewater Formation: Jour. Pal., vol. 2, No. 1, pp. 80-81, March, 1928.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 260-269, PL. 31, SEPTEMBER, 1931

NEW SCHIZOPHORIIDAE AND A TRILOBITE FROM THE KANSAS PENNSYLVANIAN

NORMAN D. NEWELL
University of Kansas, Lawrence, Kansas

ABSTRACT

Three new species and a new variety of the brachiopod genus *Enteletes* each with a definite stratigraphic range are separated from the common *Enteletes hemiplicatus* of the Mississippi Valley. The occurrence of a species of *Schizophoria* in the upper Pennsylvanian is noted, and compared with a similar association of the genus with *Enteletes* in the Moscovian of Russia. A new trilobite genus *Ditomopyge*, is described. based on minute pygidia which bear resemblance to the Devonian *Odontocephalus*. If this new form is correctly referred to the Phacopidae the range of the family is greatly extended.

The highly fossiliferous Pennsylvanian rocks of eastern Kansas have attracted paleontologists for a great many years. Most of the paleontological research has been rather incidental or in some cases extensive, rather than in any sense exhaustive. Under the elastic limits generally assigned to species in the Mid-Continent Pennsylvanian the most common forms, the brachiopods, for the greater part have little or no stratigraphic value. The fact is becoming apparent that some of the common Pennsylvanian species are characterized at definite horizons by distinctive features, often obscure, but nevertheless of stratigraphic significance.

The brachiopod genus *Enteletes* is a striking form in Pennsylvanian faunas, one that, because of its restricted range, has often been considered of great value in regional correlation. In general only one species of *Enteletes* has been recognized in the Pennsylvanian faunas of the Mississippi Valley region. In the present study four species and a variety are distinguished, each having a tested stratigraphic value.

The lack of material from the lower and upper parts of the eastern Kansas section has necessarily restricted the study to specimens from formations of the Kansas City, Lansing, Douglas, and Shawnee groups.

The genus *Enteletes* first appears in the Kansas Pennsylvanian in the upper part of the Kansas City group in the southeastern part of the

[1]The writer has discovered a serious miscorrelation between the Kansas River section and the section in southeastern Kansas. Thus the limestone containing *Enteletes* which overlies the Lane shale at Lane, Franklin County, Kansas, is the exact equivalent of the "Iola" limestone, lower "Lane" shale, and Farley limestone of the Kansas River section.

State, and in the Kansas River Valley it is unknown below the Farley limestone of the Lansing group. In Oklahoma[1] however, the genus is introduced at a much lower horizon, in beds equivalent to part of the Marmaton group of the Kansas section. In northeastern Kansas, north of Kansas River, *Enteletes* is introduced in the Plattsburg limestone. The genus makes its first appearance at progressively higher horizons from south to north across Kansas, as though the brachiopod migrated farther and farther northward from a center of distribution during successive sea advances.

The related genus *Schizophoria* is typical of the lower Pennsylvanian in America as *Enteletes* is of the upper Pennsylvanian. The occurrence of *Schizophoria* in the Stanton limestone at Fredonia, Kansas, is apparently unique in the upper Pennsylvanian of America. Girty[2] has suggested that the occurrences of *Schizophoria* in the American Pennsylvanian are not necessarily of approximately the same age.

The discovery of *Schizophoria* at the same horizon as *Enteletes pugnoides* recalls the association of two similar species in the Russian Moscovian, *Schizophoria resupinata* and *Enteletes lamarcki*.

An interesting trilobite described below has been encountered in the Plattsburg limestone of the Lansing group. The form, which is the basis for a new genus, is known from two pygidia of minute size, each bearing a pair of pygidial spines. Except for the smaller size the form bears some resemblance to the Devonian *Odontocephalus*. No similar trilobite is known elsewhere from the Upper Carboniferous. It is doubtful that the form represents the nepionic stage of *Phillipsia* or *Griffithides* since those genera would not at the same size present the mature segmentation and configuration of *Ditomopyge*. Neither *Phillipsia* nor *Griffithides* possess ancestral spines during the neanic stage since at that stage trilobites have acquired most of the generic characters and subsequent change takes place chiefly in the increase in size.

The writer wishes to express indebtedness of Dr. R. C. Moore for photographic facilities and for constructive criticism in the preparation of the illustrations.

[1]Moore, R. C., Correlation of Pennsylvanian formations of Texas and Oklahoma, Bull. Am. Assn. Petroleum Geologists, vol. 13, p. 897, 1929.

[2]Girty, G. H., Descriptions of new species of Carboniferous and Triassic fossils, U. S. Geol. Survey, Prof. Paper 152, Appendix page 433, 1927.

DESCRIPTION OF SPECIES

BRACHIOPODA

FAMILY SCHIZOPHORIIDAE SCHUCHERT

GENUS ENTELETES FISCHER DE WALDHEIM

ENTELETES PLATTSMOUTHENSIS NEWELL, N. SP.
Plate 31, figures 20-27

Shell large, globose, with the dorsal valve larger and more convex than the ventral valve. The dimensions of an adult of average size are: length, 26 mm.; width, 29 mm.; convexity, 25 mm. The same measurements of a gerontic individual are: length, 30 mm.; width, 31 mm.; height, 30 mm.; length of hinge line, 12 mm. The dorsal valve is provided with a large angular fold on either side of which are three to four small and regularly decreasing plications, the outer ones being quite small and indistinct. The broad, angular sinus of the ventral valve has three to four decreasing plications on either side of the sinus. The plications originate about a fourth of the distance from the beaks, or from about 10 to 12 mm., indicating that this form attains a much greater size than *E. hemiplicatus* before the folding of the margin takes place. The surface of the valves is marked by fine radiating lirae, spaced at the origin of the plications about 6 in the distance of 1 mm. On the ventral valve there are rather regularly distributed coarser lirae which are short and terminate abruptly in what are probably the bases of hollow spines. These coarser lirae are rare on the dorsal valve. The dental plates and median septum exposed by grinding the beak of the ventral valve are relatively long and slender, and parallel or very slightly divergent. These measure in average sized individuals 10 to 13 mm. in length. The ratio of the length of the median septum to the shell length in a number of specimens is 1:2.2.

A careful search for *E. plattsmouthensis* in the formations below the Oread limestone has failed to disclose a single specimen of the species. It is as yet unknown above the Oread. The species is more abundant at this horizon in southern Kansas than farther north. At Longton, in Elk County, Kansas, the species is abundant in the Plattsmouth limestone.

The larger specimen figured was collected by M. K. Elias from the Plattsmouth limestone near the railroad at Lecompton, Kansas. The smaller individual which is of average size was obtained by David Delo at a quarry one mile west of Sedan, Kansas.

ENTELETES PUGNOIDES NEWELL, N. SP.
Plate 31, figures 7-11

Syntrelasma hemiplicata WHITE, *1884*, 13th Rept., Geol. Survey Ind., p. 131, pl. 26, figs. 15-18.
Enteletes hemiplicata HALL AND CLARKE, *1892*, Pal. N. Y., vol. 8, pt. 1, pl. 7A, in part, fig. 45.—BEEDE, *1900*, Univ. Geol. Survey Kansas, vol. 6, p. 91, in part, pl. 12, figs. 6, 6b.
Syntrilasma hemiplicata KEYES, *1894*, Mo. Geol. Survey, vol. 5, p. 76 in part, pl. 30, figs. 8 a-d.

Shell of moderate size, measuring in mature specimens about 16 mm. in length, and 19 mm. in width; with a convexity of about 15 mm. Dorsal valve somewhat larger than the ventral valve and slightly more convex. Surface of the dorsal valve provided with a bifurcate fold bearing an incipient sinus, which though small, originates as close to the beak as do the lateral plications. In adult specimens there are generally present on the dorsal valve three plications on each side of the divided fold. Similarly the ventral valve bears a divided sinus with a small mesial fold which originates fairly early in the development of the individual. On each side occur three moderately prominent plications. Each valve presents a somewhat elliptical outline, with the beaks projecting slightly beyond the posterior margin of the hinge. The dorsal beak is larger and more recurved than that of the ventral valve. The hinge line is straight and short, about 8 mm. in length, and imparts but little angularity to the outline of the shell. The plications originate somewhat behind the middle of each valve, in the cotypes about 8 mm. beyond the beaks. The shell is ornamented with fine radiating lirae, about 6 in a distance of 1 mm. at the origin of the plications. Fairly constantly at intervals of about 1 mm. there are interposed on the ventral valve coarse lirae which terminate abruptly anteriorly exposing a minute perforation as though hollow spines had formerly been joined at these places. The dental plates and median septum of this species shown on a worn surface of the ventral valve are relatively stout and divergent. In individuals of average size these range in length from 9 to 11 mm. The ratio between the median septum and the shell length is 1:2.4.

This form is readily distinguished from other species found in the Mississippi Valley, in the incipient fold and sinus found respectively within the true sinus and fold. This species certainly resembles the European *Enteletes lamarcki* and comparison of material may show that the two are the same.

The species here described has caused considerable comment during the past, and has generally been recognized as distinct from typical *Enteletes hemiplicatus*. Since, however, it was believed to be but an individual variation of *E. hemiplicatus* no name has been suggested for the form. Schellwien[1] was probably the first to express the opinion that the form under discussion should be separated from *E. hemiplicatus*. He assigned it to *E. lamarcki* Fischer de Waldheim and placed it in Waagen's group *dorsisinuati*. Waagen,[2] however, placed *E. lamarcki* in the *ventrisinuati*, which includes those species of *Enteletes* having a sinus rather than a fold on the ventral valve. There is little doubt that both *E. pugnoides* and *E. lamarcki* represent a transition to the typical dorsisinuates which seem to be confined to a higher part of the geologic column than the ventrisinuates. Beede[3] and Girty[4] have commented on this form without venturing to give it a separate name.

In this study no specimens of *E. pugnoides* have been observed in which the bifurcation of the fold and sinus takes place later in the development than the first appearance of the lateral plications. From this observation one might suppose that the species had its origin quite early in the development of the genus. However it is possible that acceleration has introduced the specific characters earlier in the ontogeny of the individual than would otherwise be the case. Although specimens intermediate between *E. hemiplicatus* var. *plattsburgensis* and *E. pugnoides* occur, it is significant that such specimens are very rare.

The species first appears in the Kansas section near Stanton, Lane, and Greeley in Miami and Franklin counties in the Argentine-Farley limestone, the equivalent of the "Iola" and Farley limestones of the Kansas City area. In the Plattsburg limestone the species is uncommon, finally culminating and apparently becoming extinct in the Meadow limestone (lower Stanton).

The two cotypes came from the cut in the Meadow limestone at the railroad crossing about a mile northeast of Eudora, Douglas County, Kansas.

[1]Schellwien, Abhandl. K.-k. Geol. Reichsanstalt, vol. 16, part 1, p. 7, 1900.

[2]Waagen, W., Salt Range fossils, Mem. Geol. Survey India, Pal. Indica, ser. 13, vol. 1, p 562, 1887.

[3]Beede, J. W., Carboniferous Invertebrates, Univ. Geol. Survey Kansas, vol. 6, p. 92, 1900.

[4]Girty, G. H., The Guadalupian Fauna, U. S. Geol. Survey, Prof. Paper 58, p. 291, 1908.

ENTELETES HEMIPLICATUS (HALL)
Plate 31, figures 12-15

Spirifer hemiplicata, HALL, *1852*, Stanbury's Exped. to Gt. Salt Lake, p. 400, pl. 4 figs. 3a, b.—MEEK AND HAYDEN, *1859*, Proc. Acad. Nat. Sci. Phil., p. 28.
Rhynchonella angulata GEINITZ, *1866*, Carb. und Dyas. in Nebr., p. 37, tab. 3, figs. 1-4.
Enteletes hemiplicata HALL AND CLARKE, *1892*, Pal. N. Y., vol. 8, pt. 1, pl. 7A, figs. 44, (not 45), 46-52.

Shell of moderate size, relatively less inflated than most species of *Enteletes*. Dorsal valve more convex than the ventral, and provided with a relatively high, narrow, and angular fold. The lateral plications, of which there are generally two, less commonly three on each side, are also quite angular and narrow. The ventral valve has from two to three angular plications on each side of a deep and narrow sinus. The surface of both valves is marked by fine lirae radiating outward from the beaks. Small spine tubules, especially numerous on the ventral valve originate at irregular intervals from locally coarser lirae. The dorsal beak is slightly larger and more extended than the ventral beak. The dimensions of average adults are: length, 16-16 mm.; width, 18-19 mm.; convexity, 13-14 mm.; length of hinge line, 5.5 mm. The dental plates are relatively thin and slightly divergent. The slightly stouter median septum is about 7.5 mm. long in average adults. The ratio of the median septum to the shell length is 1:2.3.

This species may be readily distinguished from the variety *plattsburgensis* by the greater angularity and prominence of the fold and sinus. Figure 15 is somewhat misleading in this respect. The anterior margin is tilted downward slightly so that the relative prominence of the dorsal fold is not apparent. The short hinge line and thin dental plates are characteristic of the species.

This form seems to be most nearly like that described by Hall, and occurs at the same horizon. The species is unknown below the Plattsmouth limestone of the Oread. The specimen figured was collected from the Plattsmouth limestone at a quarry about four miles northwest of Lawrence, Kansas, on Federal highway 73.

ENTELETES HEMIPLICATUS VAR. PLATTSBURGENSIS NEWELL, N. SP.
Plate 31, figures 1-6

Shell of moderate size, inflated, with the dorsal valve considerably more convex than the ventral valve. Beak of the dorsal valve much larger and more prominent than that of the ventral valve, and more recurved than the latter. On each side of the fold and sinus occur three, or in some cases two plications which decrease in prominence laterally

so that the ridges on the sides of the shell are obsolescent. Surface of both valves marked by radiating lirae, about 6 in 1 mm. at the posterior terminals of the plications. Coarser lirae occur at intervals on the ventral valve terminating abruptly in coarse punctae. The shell surface is finely perforate. The plications are introduced about one-third of the distance from the beaks, or about 9 mm. The dimensions of average adults are as follows: length, 15 mm.; width, 18 mm.; height, 14 mm.; length of hinge line, 9 mm. The chief distinction between the dental plates and median septum of this form and of *E. hemiplicatus* is in the slightly greater thickness of the plates in the former species. The ratio of the length of the median septum to the shell length is about 1:2.3.

This variety together with *E. pugnoides* was introduced in the section at the horizon of the Argentine-Farley limestone (combined "Iola" and Farley of the Kansas City section) near Lane in Franklin County. It especially typifies the upper part of the Plattsburg limestone and occurs but rarely in the Meadow limestone. The form is unknown above the Meadow limestone.

The cotypes were collected from the upper part of the Plattsburg limestone, center of the south edge sec. 33, T. 13 S., R. 23 E., Johnson County, at a road cut.

ENTELETES TRANSVERSUS NEWELL, N. SP.
Plate 31, figures 16-19

Syntrielasma hemiplicata MEEK AND WORTHEN, *1866*, Geol. Surv. Ill., vol. 2, pp. 323, 324 in part, fig. 37; *1873*, Geol. Surv. Ill., vol. 5, p. 571, pl. 26, fig. 20.
(?) *Enteletes hemiplicata* PLUMMER AND MOORE, *1921*, Univ. of Tex., Bull. 2132, pl. 24, fig. 17.

Although there is but a single specimen of this species at hand, it displays characters so different from any of the scores of specimens examined from lower horizons that it seems desirable to distinguish the form by a separate name.

Shell of moderate size, having the dimensions: length, 18 mm.; width, 23 mm.; height, 16 mm. The valves, especially the ventral valve, are less inflated than in *E. hemiplicatus*. The broad, rounded dorsal fold and ventral sinus are more pronounced than the lateral plications. There are two plications on each side of the fold and sinus, the most lateral one being obsolescent. The beaks are nearly equal, and project outward to about the same extent, with the dorsal beak slightly recurved. Hinge line short, about 9 mm., imparting a slight angularity to the shell outline at the juncture with the sides. The surface ornamentation is about the same as in *E. hemiplicatus*. The plications originate about

half way from the beaks, or about 12 mm. The dental plates exposed by grinding the ventral beak are divergent and resemble *E. hemiplicatus* var. *plattsburgensis*. The median septum is about 9 mm. long and the dental plates about 8 mm. The length ratio between the median septum and the shell is 1:1.8.

The holotype was collected from the lower Lecompton limestone along the west side of sec. 16, T. 11 S., R. 19 E., Jefferson County. The species is known only from the Lecompton.

Genus SCHIZOPHORIA King

SCHIZOPHORIA TEXANA Girty

Plate 31, figures 28-30

? *Schizophoria texana* Girty, *1927*, U. S. Geol. Survey, Prof. Paper 152, p. 432, pl. 27, figs. 1-8.

Shell of moderate size, subelliptical in outline, somewhat inflated hinge line long, joining the lateral outlines at a distinct angle. Ventral valve but slightly convex and provided with a shallow, broad sinus. The dorsal valve is more convex than the ventral and bears a very indistinct fold. The anterior margin is insinuate at the fold, lending a slightly bilobed outline to the shell. Surface provided with indistinct, fine, radiate lirae, which might however, be more distinct on unworn material. The lirae, as in related forms, have coarser, short ridges interposed between them at fairly regular intervals. The shell is coarsely punctate. Dimensions of a typical specimen are: length, 16 mm.; width, 17 mm.; convexity, about 10 mm.

This occurrence of *Schizophoria* in the upper Pennsylvanian of North America is probably unique, since in the Pennsylvanian the genus is mainly restricted to rocks of Pottsville, Morrow, and Bend age.

From the Stanton limestone, Fredonia, Kansas, Cenemt Plant quarry, and questionably from the Farley limestone just east of De Soto, Johnson county, Kansas.

TRILOBITA

Family PHACOPIDAE Corda ?

Genus DITOMOPYGE Newell, n. gen.

The genus *Ditomopyge* is founded upon the pygidium of the type species, which has the following characters. Pygidium small, almost microscopic, with a flattened border, widest at the posterior extremity,

where it is produced into two rounded and symmetrical, backward directed spines. The area of the pygidium within the border flange is subelliptical. Axis slightly elevated and strongly defined, extending to the flange at the porterior border. Axial and pleural segments well defined, few in number. The doublure of the pygidium is considerably wider at the posterior than near the anterior margin.

The systematic position of *Ditomopyge* will not be certainly known until more complete material is discovered. The form of the pygidium recalls *Odontocephalus* from the Devonian, the distinction lying in the much greater size and ill defined border of the latter. The genus *Ditomopyge* does not resemble other known genera of Carboniferous trilobites.

DITOMOPYGE LANSINGENSIS NEWELL, N. SP.

Plate 31, figures 31-32

Test exceedingly small as compared with other adult trilobites, the pygidium of one individual measuring about 0.85 mm. in length and 0.93 mm. in width. The same dimensions in a larger specimen are, length, 1.06 mm.; width, 1.19 mm. Pygidium provided with a flattened

---

EXPLANATION OF PLATE 31

FIGS. 1-6—*Enteletes hemiplicatus* var. *plattsburgensis* Newell, n. var. (×1). 1-3, A cotype; 1, anterior view; 2, posterior view; 3, side view. 4-6, Another cotype; 4, anterior view; 5, ventral view, showing the dental plates and median septum; 6, side view.

7-11—*Enteletes pugnoides* Newell, n. sp., (×1). 7-9, One of the cotypes; 7, anterior view; 8, side view; 9, ventral view. 10, A young individual from the Argentine-Farley limestone. 11, Ventral view of another specimen showing the dental plates and median septum.

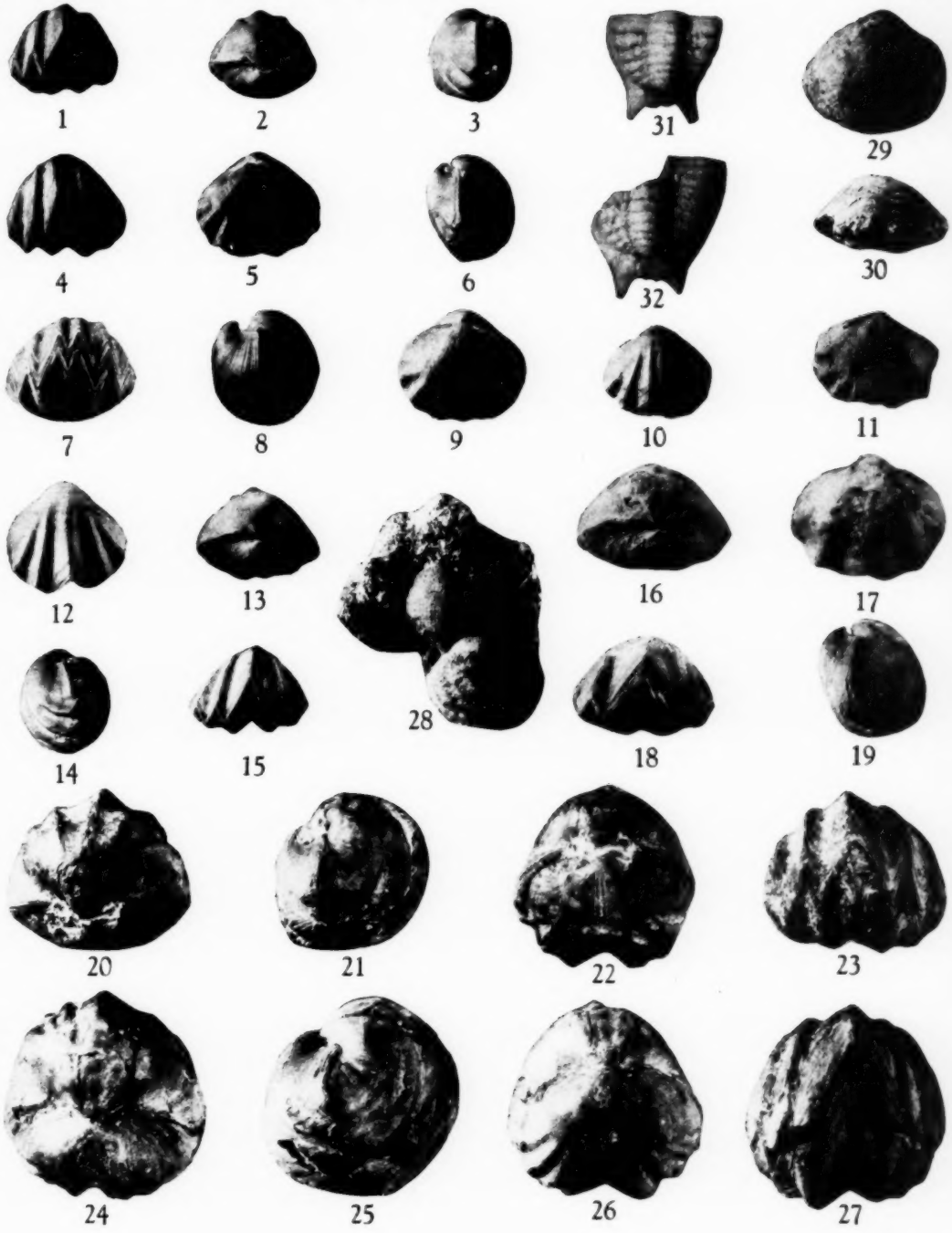
12-15—*Enteletes hemiplicatus* (Hall), (×1). 12, Dorsal view; 13, posterior view; 14, side view; 15, anterior view in which the specimen is tilted downward so that the prominence of the fold is somewhat obscured.

16-19—*Enteletes transversus* Newell, n. sp., (×1). 16, Posterior view; 17, dorsal view; 18, anterior view; 19, side view.

20-27—*Enteletes plattsmouthensis* Newell, n. sp., (×1). 20-23, An individual of average size; 20, posterior view; 21, side view; 22, ventral view, showing the dental plates and median septum; 23, anterior view. 24-27, A gerontic individual; 24, posterior view; 25, side view; 26, ventral view; 27, anterior view.

28-30—*Schizophoria texana* Girty?, (×1). 28, A young individual and an adult in the matrix. 29-30, An imperfect dorsal valve; 29, dorsal view; 30, anterior view.

31-32—*Ditomopyge lansingensis* Newell, n. gen., n. sp., (approximately × 17). 31, A nearly perfect pygidium. 32, A well preserved but broken pygidium.



Newell, Pennsylvanian Schizophoriidae and Trilobite

UNIV. OF MICH.

flange which is broadest at the posterior-lateral margin where it is produced into two short, backwardly directed and symmetrically rounded spines, and gradually narrows toward the anterior border, becoming nearly obsolete. A doublure occurs along the ventral side of the margin, being broadest at the posterior end of the pygidium. The outline of the posterior margin between the spines is faintly convex on each side of a median notch or slight indentation. Above this median deflection and immediately posterior to the extremity of the axial lobe is a small subcircular area of clear calcite filling which apparently in the living animal was a cylindrical space open above and below and on the posterior side between two projecting points of the flange. That part of the pygidium within the flange is semielliptical. The axial lobe occupies slightly less than one-third the transverse diameter of the pygidium at the anterior margin, narrowing rather gradually posteriorly to an abrupt extremity. The pleural lobes extend backward as far as the end of the axial lobe. In a pygidium having a length of 0.85 mm. and a width of 0.93 mm. there are 7 pleural segments, and about 8 axial segments; the distance between spine bases at the posterior extremity is 0.21 mm., and the greatest width of the axial lobe is 0.25 mm. In a larger pygidium having a length of 1.06 mm. and a width of 1.19 mm., there are 9 pleural segments, and about 9 axial segments; the distance between the spine bases is 0.21 mm. and the spines are about 0.17 mm. in length. Diameter of the circular space between the spines in the latter specimen, 0.127 mm.

From the calcareous yellowish shale at the middle of the Plattsburg limestone, Lansing group, on the main highway east of Ottawa, Kansas, near the Franklin County line, middle of the north line of sec. 36, T. 16 S., R. 21 E.

JOURNAL OF PALEONTOLOGY, VOL. 5, NO. 3, PP. 270-292, PLS. 32, 33, SEPTEMBER, 1931

PULMONATE MOLLUSCA PECULIAR TO THE PLEISTOCENE PERIOD, PARTICULARLY THE LOESS DEPOSITS[1]

FRANK COLLINS BAKER
Museum of Natural History, University of Illinois

ABSTRACT

The paper describes and figures the species and races of Pleistocene loess mollusca published in scattered journals during the past ten years. The environment of loess time is discussed as well as the climatic conditions under which the molluscs lived, the belief being held that during a part of the time during which loess was deposited the climate was relatively cooler than central and southern Illinois is at the present time. All of the species and races described are peculiar to Pleistocene time and are not found in the Recent fauna. Comparisons are made with the most closely related species of the Recent fauna.

INTRODUCTION

It has been held by several students of Pleistocene life that there has been little change in the species during this period and that the modern molluscan fauna is practically the same as the species that lived during this last period of geological history (Shimek, 1913) and this belief was shared by the writer (Baker, 1920, pp. 360, 369) in 1920. During the last ten years, however, a large amount of Pleistocene material from authenticated stratigraphic deposits has been critically examined with the result that several forms appear to be specifically or varietally distinct from those of their relatives living today. This opinion is based largely on collections made by field parties of the Illinois State Geological Survey and deposited in the University Museum. These collections include some 45,000 specimens and represent more than 500 separate exposures, of which 25,000 specimens from 350 exposures are of terrestrial derivation, principally loess. All horizons except the Aftonian are represented by many exposures. Only two fossiliferous deposits of undoubted Aftonian age have thus far been found in Illinois, one in Fulton County, near Enion and the other in Scott County, near Winchester. Yarmouth exposures are common as are also Peorian and Early Wisconsin. Sangamon deposits are comparatively rare, a fact hard to explain, as they should be found in abundance overlying the Illinoian till.

[1]Contribution from the Museum of Natural History, University of Illinois (No. 65) and the Illinois State Geological Survey, in coöperation. Publication aided by grant from Illinois Geological Survey.

The material on which the present paper is based was collected largely in Illinois, although some material from Iowa, Indiana, Kentucky, and Arkansas has been included. The forms differentiated from the related species of the modern fauna are represented by many specimens, often by several hundred, which has made it possible to study their variation. These have been compared with a large collection of modern species representing their geographical range. The types of the Pleistocene species and races are in the Museum of Natural History of the University of Illinois and paratypes are in the Academy of Natural Sciences of Philadelphia.

HABITAT OF THE LOESS FAUNA

The fauna of the loess probably lived under conditions practically the same as those obtaining today. The river bluffs were forested much as at present (this must have been so to hold the fine material of the loess in place) and here the larger species lived. Many of the smaller species probably inhabited open woods or thickets, or even the open prairies, as they do today. In parts of Illinois, the small modern species, like the Pupillidae and Zonitidae, are often found in great abundance on railway embankments, or in open, grass grown fields. At many places in Illinois, especially in wide flood plain areas and in wide stream valleys, the amphibious species live in shallow pools in the wet spring period. These localities later become dry and remain so for six or eight months when they are inhabited by land species which have migrated into these areas. These habitat relationships account for the almost constant association of *Pomatiopsis* and *Fossaria*, as well as *Stagnicola caperata*, with strictly land species in somes loess deposits of Illinois. About 38 per cent of the loess exposures contain *Fossaria*. *Pomatiopsis* is found in less than half this number of exposures. According to Professor Shimek, *Fossaria* and *Pomatiopsis* are more rare in the loess of Iowa.

It has been observed by Shimek, and also by the writer, that the large land pulmonates are more abundant in the southern than in the northern loess. Loess from the Mississippi bluffs and other localities in Arkansas, Mississippi, Kentucky, and southern Illinois contains an abundance of the large helices and a lesser number of the small Pupillidae and Zonitidae, whereas in the northern portion of loess territory the small Pupillidae, Zonitidae, etc., are abundant and the larger species rare or absent. A part of this variation is due to climatic differences between the two regions, similar to that which exists today.

CLIMATE

Much difference of opinion prevails concerning the climatic conditions under which the loess was deposited. Shimek holds that these conditions were not essentially different from those of today, excepting for dry or drought conditions. The period of greatest loess deposition has been thought to be about in the middle of an interglacial period, representing the warmer part of the cycle (Shimek, 1913). Although this statement is probably true in the main, there is reason to believe that the loess was not all deposited under the same climatic conditions. Loess deposition probably began in the more northern localities of Illinois soon after the retreat of the ice and in such cases the climate was essentially colder than it is in the same locality at present. Evidence of this condition has been noted in loess overlying the Bloomington moraine near Weyenet, in Bureau County, Illinois, where absence of weathering between the till and the overlying loess indicates that the loess was deposited soon after the recession of the ice.[1]

Mollusks are rare in this section and all of the smaller species, *Succinea grosvenori gelida*, *Vertigo modesta*, and a *Pupilla* resembling *hebes*, and the larger forms such as *Polygyra* and *Anguispira* are absent. It is significant that the large species are also absent from all of the loess exposures in the northern part of Illinois, such species as *Polygyra profunda*, *P. clausa*, *P. thyroides*, *P. appressa*, *P. tridentata*, *P. multilineata* and *Angiuspira solitaria* (*kochi*) being either lacking, or, in one case, represented by a well marked variety (*P. multilineata wanlessi*). The difference between the Pleistocene loess faunas of Natchez, Mississippi, and northern Illinois, as compared with the differences between the loess fauna at Natchez and the modern fauna of northern Illinois is so striking that one is at once confronted by the query as to what the former climatic conditions may have been. An answer that seems to explain perfectly the differences between the loess faunas of the different exposed areas is that the isotherms were displaced southward during at least part of the periods of loess deposition. This does not necessitate the assumption that the climate was arctic but simply that an isotherm that now occurs in southern Michigan and Wisconsin moved southward temporarily to central or southern Illinois. This conclusion is substantiated by a study of material from more than 300 loess exposures extending from Stephenson County in extreme northern Illinois to Union

[1]Exposure observed by Dr. Paul MacClintock of Princeton University.

County in southern Illinois, and considerable additional material from loess localities farther south.

A study of the vertical distribution of shells in the loess of one exposure usually shows some variation in the character of the species represented, indicating changing conditions during the loess deposition (Shimek, 1930, p. 686), some of which may as well have been due to climatic as to edaphic conditions. As far as Illinois is concerned, not enough detailed data are available for a satisfactory answer to this question. The writer does not claim, in the face of the present evidence, that the climate was at any time arctic or boreal during the period of loess deposition when the faunas lived, but he does believe that the distributional evidence is quite as readily explained by slight changes in temperature as it is by aridity, especially as the nature of the loess fauna, with its modern western species living in temperatures which are in general considerably lower than those of Illinois, points to such a conclusion.

DESCRIPTION OF SPECIES AND VARIETIES

These were originally described in the *Nautilus*, the citations being given under each species. The figures are mostly from photographs of types or are camera lucida drawings of type material. Accuracy is thus assured for each of the new forms. These are compared in all cases with the most nearly related species of the modern fauna. The geological and geographical distribution of each new form is given as shown by the collection in the Museum of Natural History and by the available literature.

POLYGYRA MULTILINEATA ALTONENSIS F. C. BAKER

Plate 33, figure 6

Polygyra multilineata altonensis, F. C. BAKER, *1920*, Nautilus, vol. 34, p. 65.

This race of *P. multilineata* differs uniformly from the modern form of the species in being somewhat larger, the body whorl larger and more gibbous, the spire usually more depressed; the last whorl notably descends a short distance behind the aperture which is wider and more rounded than in the typical form (pl. 33, fig. 7); the reflected lip is heavier and a distinct deposit of callus near the umbilical region almost assumes the character of a plait. Measurements of the race and of the typical form are noted below.

Altonensis	*Multilineata*
H. 19.5; D. 32.0; Ap. H. 14.0; D. 14.0 mm.	H. 16.5; D. 27.6; Ap. H. 10.5; D. 11.5 mm.
H. 15.5; D. 28.0; Ap. H. 11.0; D. 11.0 mm.	H. 16.5; D. 27.5; Ap. H. 10.1; D. 11.5 mm.
Types P. 740	Lafayette, Ind., Z18705

Type locality. Plant No. 2, Mississippi Lime and Materials Company, Alton, Madison County, Illinois. U. of I. collection, P740.

Horizon. Pink loess, Sangamon interval, lower ten feet of section. Collected by Dr. M. M. Leighton.

This race of the common modern land snail appears to be restricted to the Sangamon interval, no specimens having been discovered in other deposits examined during the ten years that have elapsed since its discovery at Alton. Three additional specimens were obtained from loess in Calhoun County, Illinois, in the Dug Hill section of the Brussels Quadrangle, SE. ¼ sec. 16, T. 7 N., R. 13 W., collected by Dr. Leighton and Mr. W. W. Rubey (P3522). From the scarcity of the race in Pleistocene deposits it is assumed that it was a local form, at least in Illinois. No specimens of the modern form of the species have been seen from any Illinois Pleistocene deposit earlier than Late Wisconsin.

POLYGYRA MULTILINEATA WANLESSI F. C. BAKER

Plate 32, figure 12; plate 33, figure 1

Polygyra multilineata wanlessi F. C. BAKER, *1928*, Nautilus, vol. 41, p. 132.

The race *wanlessi* differs from the modern form of the species chiefly in the uniformly smaller size of the shell, the more deeply indented umbilical region which is frequently perforate, and in the smaller, more oblique aperture, which is more rounded in the modern form. It more nearly resembles the modern race known as *algonquinensis* Nason, from which it differs in its larger size, smaller, less rounded aperture, and indented umbilical region. The body whorl in *wanlessi* is of greater diameter than in the *algonquinensis* race, and the sculpture is much coarser. The difference in the shape of the aperture is well shown in Plate 32, figs. 12, 13.

Type locality. Fulton County, Illinois, about four miles west of bridge at Havana. U. of I. collection, P2358. Philadelphia Academy, 144921.

Horizon. Peorian Interval, typical loess. Collected by Dr. H. R. Wanless, after whom the race is named.

Measurements of the fossil race and of the recent *algonquinensis* race are shown below for comparison (pl. 33, fig. 2).

Wanlessi		*Algonquinensis*	
H. 14.0; D. 21.5 mm.	Holotype.	H. 5.6; D. 17.0 mm.	Types
H. 13.0; D. 21.0 mm.	Paratype.		
		H. 5.2; D. 16.5 mm.	Types
H. 12.6; D. 19.5 mm.	Paratype.	H. 6.3; D. 17.5 mm.	Types
H. 11.1; D. 18.5 mm.	Paratype.	H. 7.1; D. 17.2 mm.	Types
H. 12.3; D. 17.2 mm.	Lewistown, Ill.	H. 7.4; D. 17.4 mm.	Types
H. 9.0; D. 15.1 mm.	Lewistown, Ill.	H. 8.0; D. 19.3 mm.	Types.

Nason's types of *algonquinensis* from Algonquin, McHenry County, Illinois, are in the Natural History Museum, No. Z20720, seven specimens. Forty specimens of this race from the type locality, collected by Dr. Nason, are also in the museum collection.

Comparative measurements of the height of the aperture in the modern *multilineata* and the fossil *wanlessi* show a decidedly uniform difference; 16 specimens from Indiana have diameter of shell 21 to 28 mm. height of aperture 9 to 10.5 mm.; 22 specimens from Michigan, diameter 20 to 25 mm., height of aperture 8 to 10 mm.; 18 specimens from Wisconsin, diameter 19 to 23 mm., height of aperture 7 to 8.6 mm. Forty specimens of *wanlessi*, diameter 16 to 21 mm., have height of aperture ranging from 5.2 to 7 mm. Three specimens measured 7.6, 7.8, and 8 mm. in height. *Wanlessi* is represented by 105 specimens from 28 exposures, these exposures being: Yarmouth, 2 loess, 4 old soil; Peorian 18, all loess; Early Wisconsin, 2 flood plain silt. Only two specimens have been seen in Sangamon deposits.

Wanlessi is apparently the common form of this species in the larger part of the Pleistocene, extending from Yarmouth to Early Wisconsin time. It was widespread geographically, occurring from Iowa eastward to Indiana. As far as the material in the museum indicates, the typical form does not appear until Early Wisconsin time and the race *algonquinensis* until Recent or at most Late Wisconsin time. *Wanlessi* seems to disappear in Early Wisconsin time.

The *multilineata* type of land snail appears to have two forms in the modern fauna and three in the Pleistocene fauna, as shown below:

P. multilineata typical, Early Wisconsin and modern fauna.

P. multilineata algonquinensis, Modern fauna only.

P. multilineata wanlessi, Yarmouth to Early Wisconsin time.

P. multilineata altonensis, Sangamon interval only.

POLYGYRA PROFUNDA PLEISTOCENICA F. C. BAKER

Plate 32, figure 15; plate 33, figure 3

Polygyra profunda pleistocenica F. C. BAKER, *1920*, Nautilus, vol. 34, p. 66.

Shell uniformly averaging smaller than typical *profunda* (pl. 33, fig. 5), the aperture of uniformly less height and comparatively greater width.

Type locality. Madison County, corner Market and East 6th Street, Alton, Illinois. U. of I. collection, P751.

Horizon. Sangamon Interval, typical pink loess. Collected by Dr. M. M. Leighton.

The figures, Plate 32, figures 14, 15, show the differences between the Recent species and the race *pleistocenica*, the principal feature being the shape of the aperture. The Recent typical form measures from 24 to 28 mm. in greater diameter, the fossil race 21 to 27 mm. Forty-five specimens of the fossil race measured 21 to 24 mm., only 5 specimens measuring more than 24 mm. Of 200 specimens of *profunda* from the modern fauna only about six per cent measured as low as 24 mm., and none had the narrow aperture of the fossil race.

Comparing the height of the aperture in the two forms, 21 specimens from Morris, Illinois, measure 9.5 to 10.5 mm., one specimen only 9 mm.; 25 specimens from Indiana measure 9.5 to 10.5 only one specimen as low as 8.6 mm.; 20 specimens from Kentucky measure 9 to 9.5 mm.; 17 specimens from Virginia measure 9 to 10.5 mm., only two specimens measure 8 to 8.5 mm. Of *pleistocenica*, 30 specimens from Sangamon loess at Alton measure 7 to 7.5 mm., only 7 specimens measure as much as 8 mm. From Peorian loess 33 specimens measure from 6.8 to 8 mm., 9 specimens measure 8 mm. In Early Wisconsin time the race becomes larger, the aperture measuring 8 and 9 mm. in height.

The fossil race somewhat resembles the modern race *strontiana* Clapp (1916, p. 537) from the Lake Erie region, both races being of about the same size (pl. 33, fig. 4). However, *strontiana* has a higher spire and a very oblique aperture, giving the shell an appearance quite different from the small Pleistocene form. A collection of *profunda* from Scott County, Virginia, has a few specimens with a narrow aperture, both these shells are much larger than any *pleistocenica*.

The range of the fossil race is from Yarmouth to Early Wisconsin time, the following exposures being represented in the museum collections: Yarmouth 1; Sangamon 7; Peorian 3; Early Wisconsin 3. As far as the material in the museum is concerned, the large modern form of *profunda* does not appear until Early Wisconsin time; during this period both the large form and the smaller form with the narrow aperture are found, although not in the same exposures; and in Late Wisconsin time only the form with large aperture is found. Excluding the color varieties, the *profunda* type of land snail has the following variation in Pleistocene and Recent time:

P. profunda typical. Early Wisconsin to modern fauna.
P. profunda strontiana. Modern fauna only.
P. profunda pleistocenica. Yarmouth to Early Wisconsin time.

POLYGYRA MONODON PEORIENSIS F. C. BAKER

Polygyra monodon peoriensis F. C. BAKER, *1927*, Nautilus, vol. 40, p. 115.

Type locality. Adams County, Illinois, Municipal quarry near Quincy. U. of I. dollection, P1910. Philadelphia Academy, 142708.

Horizon. Peorian loess.

A restudy of this fossil race in comparison with nearly 300 specimens of *monodon* from the Recent fauna, makes it doubtful if the Pleistocene form can be recognized as anything but a local mutation. The specimens from Adams County, Illinois, all from Peorian loess, are smaller than the average modern *monodon*, have a smaller umbilical opening, and a less elevated parietal lamina. But this variation is also found in a recently-acquired lot of *monodon* from Algonquin County, Illinois. At most the fossil race could be retained only for the material from the type locality, all other Pleistocene material, from Yarmouth to Late Wisconsin time, being undoubtedly referable to the modern *monodon*. The species of the modern fauna shows great variation in size and in the shape of the parietal lamina. In greater diameter the *peoriaensis* form measures 5.6 to 6.8 mm., whereas the recent form measures from 6.6 to 8.4 mm.

POLYGYRA HIRSUTA YARMOUTHENSIS F. C. BAKER

Plate 32, figure 17 A-B

Polygyra hirsuta yarmouthensis F. C. BAKER, *1927*, Nautilus, vol. 40, p. 114.

This shell differs from the modern *hirsuta* (pl. 32, fig. 16 A-B) in being uniformly smaller, with a higher and thicker parietal lamina which completely fills the aperture in front view (pl. 32, fig. 17 A), the basal lip is heavier with the median notch much deeper than in *hirsuta*, the elevations on each side of the notch standing up like two distinct tubercles or teeth (pl. 32, fig. 17 B); a deep sinus just beneath the tubercles makes the notch and tubercles stand on a ridge, and a conspicuous nodule on the lower lip near the outer edge of the aperture forms a third tooth. The umbilical region is never indented as in *hirsuta*, the lower and upper lips being in the same plane; there is frequently a distinct umbilical opening in *yarmouthensis*.

Type locality. Clark County, Illinois, three miles southwest of Marshall. U. of I. collection, P2085. Philadelphia Academy, 142707.

Horizon. In loessial silt of Yarmouth age.

This race of *hirsuta* is uniformly different from the typical modern form, the small size and differently armed aperture making it easily distinguishable. The shape of the aperture recalls both *P. pilula* Pilsbry

EXPLANATION OF PLATE 32

FIGS. 1—*Gonyodiscus shimekii* (Pillsbry), × 3. Winchester, Scott Co., Ill. U. of I. coll. P4212.

2—*Gonyodiscus cockerelli* (Pilsbry), × 3. Navajo Mt., Utah. U. of I. coll. Z31228.

3—*Gonyodiscus macclintocki* F. C. Baker, × 3. 3½ miles west of Lewistown, Fulton Co., Ill. Paratype, U. of I. coll. P2367.

4—*Gonyodiscus perspectivus* (Say), × 3. Du Bois, Washington Co., Ill. U. of I. coll. Z31229.

5—*Pomatiopsis lapidaria* (Say), × 6. *A*, Mahomet, Champaign Co., Ill. U. of I. coll. Z31237. *B*, Lawrenceburg, Ind. Sangamon interval. U. of I. coll. P4214.

6—*Pomatiopsis scalaris* F. C. Baker, × 6. New Harmony, Ind. Type, U. of I. coll. P2321.

7—*Vertigo ventricosa* Morse, × 10. Woodland, Aroostook Co., Maine. U. of I. coll. Z31235.

8—*Vertigo elatior* Sterki, × 10. Woodland, Aroostook Co., Maine. U. of I. coll. Z31236.

9—*Vertigo loessensis* F. C. Baker, × 10. *A*, 3½ miles west of Lewistown, Fulton Co., Ill. U. of I. coll. P2366, Type. *B*, Loess at New Harmony, Ind. U. of I. coll. P4213.

10—*Fossaria parva* (Lea), × 5. *A* and *B*, Cleveland, Ohio. U. of I. coll. Z31238. *C*, Des Moines, Ia. U. of I. coll. Z31239.

11—*Fossaria parva tazewelliana* (Wolf), × 5. 4 miles west of Havana, Fulton Co., Ill. U. of I. col. P4215. *A* and *B*, adult; *C*, immature.

12—*Polygyra multilineata wanlessi* F. C. Baker, × 3. 4 miles west of Havana, Fulton Co., Ill. Paratype, U. of I. coll. P2358.

13—*Polygyra multilineata algonquinensis* Nason, × 3. Algonquin, Ill. Type lot, U. of I. coll. Z31223.

14—*Polygyra profunda* (Say), × 3. Morris, Grundy Co., Ill. U. of I. coll. Z31224.

15—*Polygyra profunda pleistocenica* F. C. Baker, × 3. Alton, Ill. Type, U. of I. coll. P751.

16—*Polygyra hirsuta* (Say), × 3. Carbondale, Ill. U. of I. coll. Z31240.

17—*Polygyra hirsuta yarmouthensis* F. C. Baker, × 3. Clark Co., Ill. Type, U. of I. coll. P2085.

18—*Succinea grosvenori* Lea, × 3. Kenmore, N. D. *A*, adult; *B*, immature. U. of I. coll. Z21230.

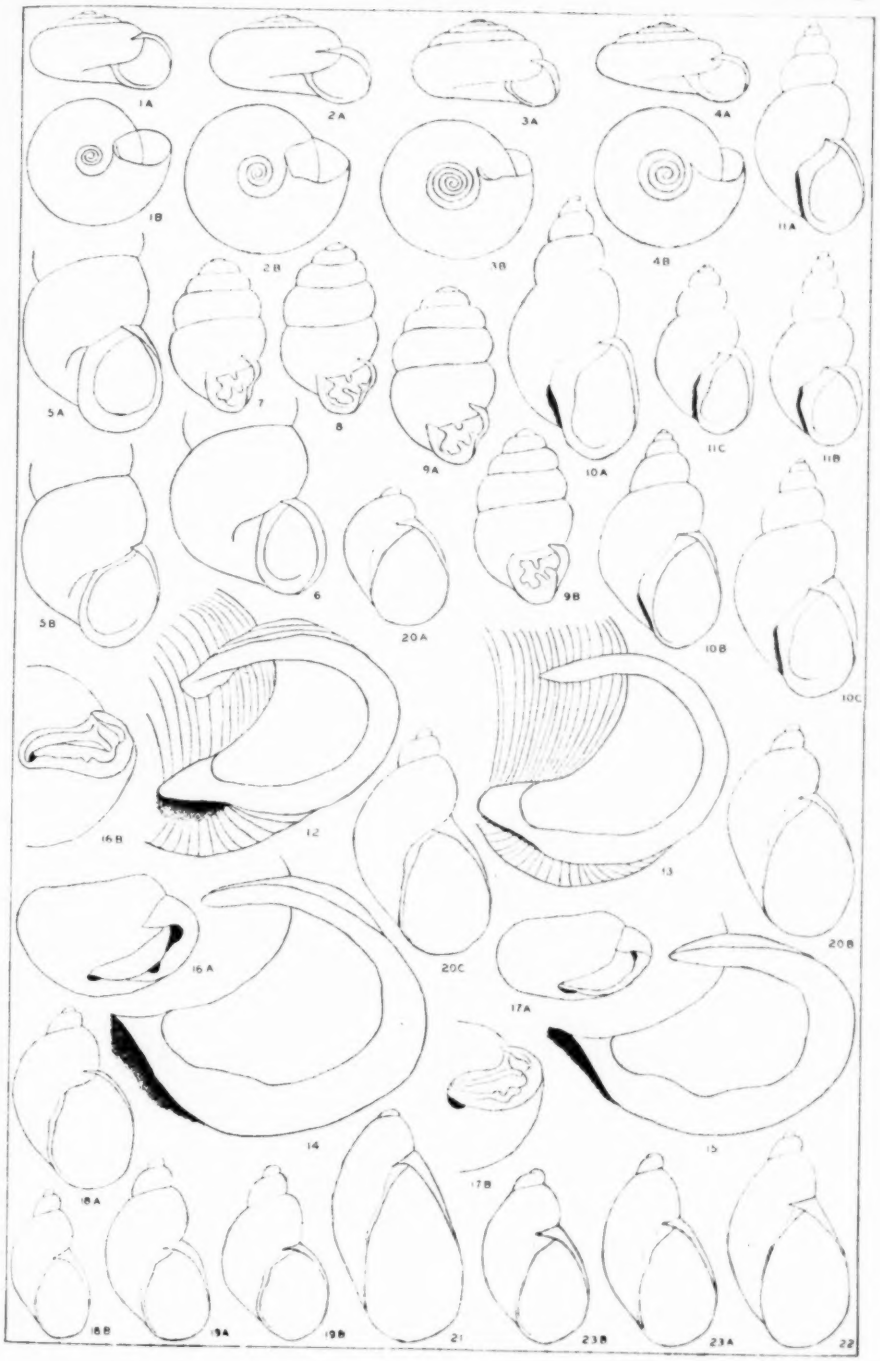
19—*Succinea grosvenori gelida* F. C. Baker, × 3. Near Irene, Boone Co., Ill. *A*, type. *B*, paratype. U. of I. coll. P875.

20—*Succinea avara* Say, × 3. *A* and *B*, type locality, New Harmony, Posey Co., Ind. U. of I. coll. Z31232. *A*, immature specimen similar to type of *S. avara; B*, mature specimen similar to type of *S. vermeta* Say; *C*, Monroe Co., Mich. U. of I. coll. Z31231.

21—*Succinea retusa* Lea, × 3. Kishwaukee River bottoms, Winnebago Co., Ill. U. of I. coll. Z41233.

22—*Succinea retusa decampi* Tryon, × 3. Canton, Gulton Co., Ill. U. of I. coll. Z31234.

23—*Succinea retusa fultonensis* F. C. Baker, × 3. 2¼ miles west of Lewistown, Fulton Co., Ill. *A*, type; *B*, paratype. U. of I. coll. P2368.


1A
2A
3A
4A
1B
2B
3B
4B
11A
5A
7
8
9A
10A
11C
11B
5B
6
20A
9B
10B
10C
16B
12
13
20B
16A
20C
17A
14
15
18A
17B
18B
19A
19B
21
23B
23A
22

and *P. decepta* Clapp, both small forms of the modern fauna. *P. pilula* is more globose and the parietal lamina is not as heavy as that of *yarmouthensis*. *P. decepta* differs in the shape of the parietal lamina and the lower lip notch. Were it not for the presence of larger, almost intermediate forms in several Pleistocene deposits, which indicate a relationship with *hirsuta*, *yarmouthensis* would easily constitute as distinct a species as either *decepta* or *pilula*.

Forty-four specimens of *yarmouthensis* measure in greater diameter from 5.8 to 7.5 mm. Fifty specimens of the modern *hirsuta* from Illinois, Indiana, and Ohio measure in greater diameter from 7 to 9 mm. Among the *yarmouthensis* specimens 75 per cent are umbilicated more or less, whereas in the modern lots none are umbilicated.

Stratigraphically *yarmouthensis* extends from Yarmouth to Early Wisconsin time. Typical *hirsuta* is also distributed from Yarmouth to Early Wisconsin time, but continues on through Late Wisconsin to the present. No true *yarmouthensis* have been seen from exposures later than Early Wisconsin. The following exposures have yielded specimens of *yarmouthensis:* Yarmouth, 6; Sangamon, 2; Peorian, 2; Early Wisconsin, 3. *P. hirsuta* is present in collections from the following exposures: Yarmouth, 1; Sangamon, none; Peorian, 5; Early Wisconsin, 3; Late Wisconsin, 3. The modern material in the museum collection covers the range of the species.

Apparently only two forms of the *hirsuta* type of shell occur in Pleistocene deposits, typical *hirsuta* and the variety *yarmouthensis*, although in the modern fauna at least four forms occur, *hirsuta*, *pilula*, *altispira*, and *decepta*. A small form of *hirsuta* found in Pennsylvania, Tennessee, and perhaps southern New York, should possibly be referred to *de epta*. The aperture is quite different from that of *yarmouthensis*.

GONYODISCUS SHIMEKII (PILSBRY)

Plate 32, figures 1 A, B

Zonites shimekii PILSBRY, *1890*, Nautilus, vol. 4, p. 3; *1890*, Proc. Acad. Nat. Sci. Phil., p. 297, pl. 5, figs. 9-11. Types in Philadelphia Academy.

Gonyodiscus shimekii appears to be varietally distinct from *Gonyodiscus cockerelli* Pilsbry, the latter having finer scuplture on the spire whorls, a wider umbilical opening, more depressed form and on the average a less rounded aperture. *Cockerelli* (pl. 32, fig. 2 A, B) should certainly be considered a subspecies of *shimekii*. Specimens of *cockerelli* from Utah, Colorado and New Mexico, and named by Dr. Pilsbry, have been examined by the writer.

Shimekii is an abundant fossil in Iowa but has not been found in the eastern part of Illinois. It is known at present from Bureau, Fulton, and Warren counties, in Peorian loess, and Shimek has recorded it from Yarmouth and Peorian loess in Iowa. It is not known apparently, from deposits later than Peorian. As might be expected, in the case of a variety, there is some variation in each race toward the other form. The differences in sculpture and size of the umbilical opening appear to be constant, however, in the specimens examined.

A modern form, said by Pilsbry to be about intermediate between *shimekii* and *cockerelli*, occurs in Kananaskis, Alberta, and may possibly be considered the modern equivalent of *shimekii* (Berry, 1922, p. 10). If so, it indicates a far greater Recent northward range of the species than in Pleistocene time.

GONYODISCUS MACCLINTOCKI F. C. BAKER

Plate 32, figures 3 A, B

Gonyodiscus macclintocki F. C. BAKER, *1927*, Nautilus, vol. 41, p. 133.

This common Pleistocene shell is one of the most distinct species occurring in this geological period. It resembles the common modern *Gonyodiscus perspectivus* (pl. 32, figs. 4 A, B) in a general way, but differs radically in form and sculpture. Compared with *perspectivus* it has an elevated, dome-shaped instead of a depressed spire; the sculpture is finer and there are more ribs in a measured space; the base is striate or with fine ribs, whereas the modern form has distinct rib-striae; the umbilicus is round, small and deep, whereas that of *perspectivus* is large and shallow; the body whorl is wide and rounded, not compressed and flattened; the aperture is about as wide as high, whereas in the modern species it is usually wider than high; and the nuclear whorl is usually larger in *macclintocki*. The size is always smaller in adult shells. Among several hundred *macclintocki* the largest does not exceed 7.5 mm. in greater diameter, the majority being 6.0 to 6.6 mm.; in *perspectivus* the largest shells measure 9.2 mm. in greater diameter, the average being 8.3 mm. Of the modern species more than 500 specimens have been examined, ranging in distribution from Iowa east to Ohio and from Michigan south to Alabama and North Carolina.

Type locality. Fulton County, 3½ miles east and 1¾ miles south of Lewistown, Liverpool Township, Illinois. U. of I. collection, P2367. Philadelphia Academy, 145108.

Horizon. Peorian loess.

A somewhat larger shell, angulated on the periphery, found chiefly in deposits of Yarmouth age, has been differentiated as variety *angulata* F. C. Baker (Nautilus, 1927, vol. 41, p. 134. U. of I. collection, P2359; Philadelphia Academy, 144922. Locality Fulton County, Illinois, west of Havana, in Yarmouth loess). Although this feature is more or less variable in large collections of shells, there still appear to be two well-defined variations in the *macclintocki* material, one smaller with rounded whorls, narrow and deep umbilicus, the other with more depressed whorls, a wider, more shallow umbilicus, and a more angulated umbilical opening. The latter, the *angulatus* form, is always larger, measuring from 7.8 to 8.1 mm. in greater diameter. The variation occurs throughout Yarmouth and Peorian time and probably extends backward into the Aftonian interval. This variation has the dome-shaped spire and finer sculpture of *macclintocki* and not the flattened spire and coarse rib-striae of *perspectivus*.

Typical *macclintocki* ranges from Yarmouth to Early Wisconsin time, being most abundant in Peorian time. The *angulatus* from ranges from Aftonian to Peorian time. The collections studied are as follows: Aftonian, 2 specimens from 2 exposures; Sangamon, none; Peorian, 250 specimens from 20 exposures, all loess; Yarmouth, 23 specimens from 8 exposures, 5 loess and 3 old soil; Early Wisconsin, 6 specimens from an exposure on glacial outwash material on the Shelbyville moraine. It is evidently rare in Early Wisconsin time. None has been seen from Late Wisconsin exposures.

The relationship of *macclintocki* to *perspectivus* is not clear. All of the fossil *perspectivus* form of shell had been identified as the modern form by previous students. In Illinois, no typical *perspectivus* has been seen from exposures earlier than Late Wisconsin. All fossil specimens have been clearly *macclintocki*. Specimens from near Lawrenceville, Indiana, in deposits thought to be of Sangamon age, are all of the *perspectivus* type. The form found in the loess deposits of the lower Mississippi region near Natchez is *perspectivus*. The lack of abundant fossil material of the typical *perspectivus* form in our collections forbids more definite comparisons of geological distribution at present. There were evidently two species in Pleistocene time, *perspectivus* and *macclintocki*, the latter common in Iowa and Illinois.

Macclintocki has been confused with *shimekii* by many students, including the writer, who in a previous paper confused small specimens of *macclintocki* with *shimekii* (Nautilus, 1927, vol. 40, p. 116). The

latter has but 4½ whorls whereas the former has 5½. The two species are so different that comment is unnecessary.

SUCCINEA OVALIS PLEISTOCENICA F. C. BAKER

Plate 33, figures 8 A, B

Succinea ovalis pleistocenica F. C. BAKER, *1927*, Nautilus, vol. 40, p. 117.

These shells differ from typical *ovalis* in possessing a rounder aperture and longer spire. In *ovalis* the aperture occupies more than 60 per cent of the length, while in *pleistocenica* it occupies 59 per cent or less (pl. 33, figs. 9 A, B). These shells are more regularly ovate than *S. ovalis*.

L. 19.0; D. 11.5; Ap. L. 11.5; D. 8.0 mm.	Type. (P2088).
L. 17.2; D. 10.0; Ap. L. 10.0; D. 5.5 mm.	Paratype (P2088).
L. 15.0; D. 9.3; Ap. L. 9.4; D. 6.5 mm.	Paratype (P2088).
L. 22.0; D. 11.0; Ap. L. 14.4; D. 8.8 mm.	Modern, Wabash Co., Ill. (Z23742).
L. 19.5; D. 11.2; Ap. L. 13.1; D. 8.0 mm.	Modern, Wabash C., Ill. (Z23742).
L. 19.0; D. 10.5; Ap. L. 12.8; D. 7.3 mm.	Modern, Wabash Co., Ill. (Z23742).

Type locality. Clark County, Illinois, three miles southwest of Marshall. U. of I. collection, P2088. Philadelphia Academy, 142710.

Horizon. Yarmouth interval in loessial silt.

The common *Succinea ovalis* of the Pleistocene differs more or less uniformly from the modern form of the species in the characteristics mentioned above. The aperture resembles that of some specimens of *ovalis* from near Philadelphia but the spire is always longer and the form more elongate ovate. Some large specimens of *S. ovalis optima* are somewhat similar but the aperture is always more elongated and the Pleistocene form never attains the dimensions of *optima*. The Pleistocene form is quite as different from typical *ovalis* as is the variety *optima*. (See Pilsbry, 1908, p. 45.) In Professor Shimek's paper on *Succinea* (1913, pl. 1, fig. 8) this race is characteristically figured.

The large fossil *Succinea* is one of the most abundant in point of numbers of any of the Pleistocene land species, the museum collection containing more than 600 specimens distributed as follows: Aftonian, none from Illinois (Shimek records *ovalis* from the Iowa Aftonian; Baker, 1920, p. 227); Yarmouth, 73 specimens from 14 exposures of which 9 are loess; Sangamon, 10 specimens from two exposures; Peorian, 500 specimens from 30 loess exposures; Early Wisconsin, 18 specimens from 3 exposures, all silt deposits. Comparisons have been made with 250 modern specimens of *ovalis* and its varieties ranging geographically from

Iowa eastward to Rhode Island, and from Minnesota southward to Kentucky.

Succinea ovalis includes the following varieties, modern and fossil:

S. ovalis, Early Wisconsin to modern fauna.
S. ovalis pleistocenica, Aftonian to Early Wisconsin time.
S. ovalis optima, modern fauna only.
S. ovalis chittenangoensis, modern fauna only.

The typical, long-aperture form does not appear, in Illinois, until Early Wisconsin time, and the specimens in these exposures are variable. All of the Late Wisconsin material is without doubt referable to typical *ovalis*. Outside of Illinois, however, the typical form may occur in earlier deposits. The large *Succinea* from deposits near Lawrenceburg, supposed to be of Sangamon age, are clearly of the *ovalis* form and not the race *pleistocenica*. This deposit is an old soil and not loess. The race *pleistocenica* appears to be characteristic of the older loess from Iowa eastward to Indiana. Most specimens of this *Succinea* from the loess of the lower Mississippi appear to belong to the typical form.

SUCCINEA GROSVENORI GELIDA F. C. BAKER

Plate 32, figures 19 A, B

Succinea grosvenori gelida F. C. BAKER, *1927*, Nautilus, vol. 40, p. 118.

This variety differs from the modern *grosvenori* (pl. 32, fig. 18 A) in being uniformly smaller, narrower, with a longer spire and smaller, rounder aperture. The whorls are also rounder and the sutures deeper.

L. 8.0; D. 4.2; Ap. L. 4.0; D. 2.4 mm.	Type. (P875).
L. 7.3; D. 4.0; Ap. L. 3.5; D. 2.3 mm.	Paratype (P875).
L. 6.8; D. 4.5; Ap. L. 3.7; D. 2.2 mm.	Paratype (P875).
L. 11.0; D. 6.0; Ap. L. 6.1; D. 4.0mm.	Recent *grosvenori*, N. D. (Z10416).
L. 13.0; D. 7.5; Ap. L. 7.5; D. 4.0 mm.	Recent *grosvenori*, Ariz. (Z10160).

Type locality. Boone County, Illinois, ½ mile northeast of depot at Irene. U. of I. collection, P875. Philadelphia Academy, 142712.

Horizon. Peorian loess.

Were it not for the presence of certain small, apparently immature forms of *grosvenori* which occur with specimens of this species from Kenmore, N. D., the Pleistocene *Succinea* would certainly constitute a most distinct species as it shows very little variation in either size or form. The small North Dakota specimens are evidently immature, having half a whorl less than the larger specimens with which they are associated (pl. 32, fig. 18 B).

This small *Succinea* of the Pleistocene has been identified as *avara*, *vermeta* and *grosvenori*. It lacks the elongated aperture of *avara*, being smaller than this form when adult (see pl. 32, fig. 20). It is to be noted that Say's *avara* is founded on a young shell (three-twentieths of an inch or about 4 mm. (pl. 32, fig. 20 A) and his *vermeta* on an adult shell (pl. 32, fig. 20 B). In any large lot of *avara* the variation from the small to the large form may be seen. *S. vermeta* is absolutely synonymous with *S. avara*. Shimek figures the fossil race under the name of *avara* on his *Succinea* plate (1913, pl. 1, fig. 10). *Succinea grosvenori* (mostly under the name *Succinea lineata*) has been listed in certain Pleistocene deposits of Iowa and elsewhere (Baker, 1920, for reference). No true *grosvenori* have been found in Pleistocene deposits from Illinois or Indiana, so far as known, and it is not present in the modern fauna of either of these states (the record of Wolf and Nason from Fulton County, needs substantiation. See Baker, 1906, p. 114). Shimek has reported *grosvenori* from a number of loess deposits in Iowa where, also, the modern form of the species is found in the western part of the state. The small fossil *Succinea* is referred by Shimek to *avara* but its rounder aperture makes it appear more nearly related to *grosvenori*.

This fossil race of *grosvenori* is by far the most abundant species represented in Pleistocene land deposits. More than 1,500 specimens from more than 70 different exposures are in the museum collection. These may be divided as follows: Aftonian, none; Yarmouth, 32 specimens from 11 exposures, five of these loess; Peorian, 45 exposures represented by more than 1,200 specimens, all from loess deposits; Sangamon, 46 specimens from two exposures; Early Wisconsin, 457 specimens from 20 exposures, 11 of which are loess. None have been seen from Late Wisconsin deposits. Comparisons have been made with more than 300 specimens of recent *avara* ranging geographically from Ontario, Canada, south to Arizona, and from Iowa east to Rhode Island. Upward of 100 specimens of *grosvenori* have been studied, ranging from North Dakota southward to Arizona and Texas.

Typical *avara* apparently appeared in Early Wisconsin time. It is common in deposits of Early Wisconsin age in Illinois and Indiana and in Late Wisconsin deposits in Illinois, Michigan, and Wisconsin. According to Shimek, *grosvenori* occurs in Iowa in deposits of Yarmouth and Peorian age. Of these small forms of *Succinea* there are in the Pleistocene and modern of the central west:

S. grosvenori, Yarmouth to modern fauna.
S. grosvenori gelida, Yarmouth to Early Wisconsin time.
S. avara, Early Wisconsin to modern fauna.

SUCCINEA RETUSA FULTONENSIS F. C. BAKER
Plate 32, figures 23 A, B

Succinea retusa fultonensis F. C. BAKER, *1928*, Nautilus, vol. 41, p. 136.

This fossil *Succinea* most nearly resembles the race *decampi* (pl. 32, fig. 22) of the modern fauna, differing in its smaller size, smaller, more ovate aperture, and relatively longer spire. In *decampi* the aperture occupies about 70 per cent of the length whereas in *fultonensis* it occupies about 60 per cent of the length.

Type locality. Fulton County, Illinois, 2¼ miles west and ¾ mile south of Lewistown. U. of I. collection, P2368. Philadelphia Academy, 145109.

Horizon. Early Wisconsin gray silt.

This *Succinea* is apparently rare in the Pleistocene. The following horizons are represented in the museum material: Yarmouth, 15 specimens from one deposit; Peorian, four specimens from three deposits; Early Wisconsin, seven specimens from four deposits. None has been seen from strata later than Early Wisconsin, all specimens from Late Wisconsin deposits being *retusa* or *decampi*. The majority of the deposits in which *fultonensis* is found are loess, only one exposure being silty and this is clearly a land deposit. On the contrary, the majority of the *retusa* (pl. 32, fig. 21) in the collection from Early and Late Wisconsin time are from aquatic material, indicating that the race *fultonensis*

EXPLANATION OF PLATE 33

All figures enlarged 1½ diameters.

FIGS. 1—*Polygyra multilineata wanlessi* F. C. Baker. Peorian loess 2 miles south of Lewistown, Fulton Co., Ill. U. of I. coll. P4206.

2—*Polygyra multilineata algonquinensis* Nason. Algonquin, McHenry Co., Ill. Type lot, U. of I. coll. Z31223.

3—*Polygyra profunda pleistocenica* F. C. Baker. Pink Sangamon loess, Alton, Ill. Type lot, U. of I. coll. P751.

4—*Polygyra profunda strontiana* Clapp. Strontian Island, Lake Erie, Ohio, U. of I. coll. Z31226.

5—*Polygyra profunda* (Say). Morris, Grundy Co., Ill. U. of I. coll. Z31225.

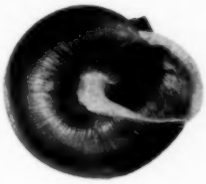
6—*Polygyra multilineata altonensis* F. C. Baker. Late Sangamon loess, Dug Hill, Calhoun Co., Ill. U. of I. coll. P4207.

7—*Polygyra multilineata* (Say). Lafayette, Tippecanoe Co., Ind. U. of I. coll. Z31224.

8—*Succinea ovalis pleistocenica* F. C. Baker. Peorian loess about 4 miles west of bridge at Havana, in Fulton Co., Ill. U. of I. coll. P4208.

9—*Succinea ovalis* Say. Wabash Co., Ill. U. of I. coll. Z31227.

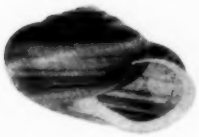
1A



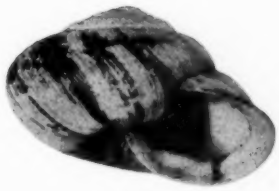
2A

3

1B

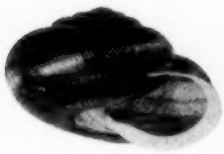


2B



4

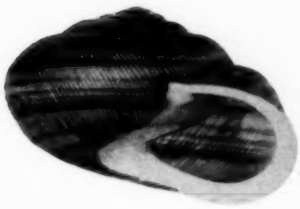
1C



2C

5

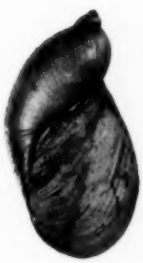
6



7

8A

8B



9A

9B

Baker, Pleistocene Mollusca

did not live as amphibious a life as do the more typical members of the species today.

The variation of *Succinea retusa* appears to be as follows:

S. retusa, Early Wisconsin to modern fauna.
S. retusa fultonensis, Yarmouth to Early Wisconsin time.
S. retusa decampi, Late Wisconsin to modern fauna.
S. retusa magisler, modern fauna only.
S. retusa peoriensis, modern fauna only.

VERTIGO LOESSENSIS F. C. BAKER

Plate 32, figure 9 A, B

Vertigo gouldii loessensis F. C. BAKER, *1928*, Nautilus, vol. 41, p. 135.

This *Vertigo* is related to the *ventricosa* group rather than to the *gouldi* group to which it has been previously referred. It differs from *ventricosa* (pl. 32, fig. 7) in its larger size and in the more massive character of the palatal plicae and in the presence of a palatal callus. It is most nearly related to *elatior* (pl. 32, fig. 8) from which it differs in its more ventricose shape and particularly in the very heavy callus in the palate upon which the palatal plicae are placed. The laminae and plicae are also much heavier and more conical in *loessensis* than in *elatior*. L. 2. 0; D. 1.3 mm. Type. L. 2. 1; D. 1.3. mm. Paratype.

Type locality. Fulton County, Illinois, 3½ miles west and 1¾ miles south of Lewistown. U. of I. collection, P2366. Philadelphia Academy, 145107.

Horizon. Peoria loess.

This *Vertigo* has been referred to both *gouldii* and *ventricosa*, but is distinct from both. Its nearest ally is *Vertigo elatior* Sterki, and Sterki has referred certain *Vertigo* from the loess at New Harmony, Indiana, to *elatior*. The fossil form, however, differs from any Recent specimens of *elatior* examined, including a number from Aroostook County, Maine, in having the palatal plicae placed on a heavy callus from which they appear to rise, while in *elatior* the plicae run backward and merge with the callus. All of the plicae are heavier in *loessensis*. The related species are compared in Plate 32, figures 7 to 9 B.

Specimens from Gallatin County loess (Early Wisconsin) were previously referred to *gouldi* (Baker, 1928, p. 289) and small forms from Clark and Adams counties were referred to *ventricosa* (l. c., p. 288). All referable to *loessensis*. No true *ventricosa* have been seen from deposits earlier than late Wisconsin.

The geological distribution of *loessensis* includes: Aftonian silt, one specimen; Yarmouth loess 22 specimens from four exposures, one specimen from old soil; Peorian loess, 50 specimens from 11 exposures; Early Wisconsin 20 specimens from two exposures, one specimen from silt; Shelbyville silt, 13 specimens from one exposure. The geographic distribution includes Illinois, Indiana, Ohio, and Kentucky. No specimens of the *ventricosa* group have been seen from Iowa. Todd's reference to *gouldii* (Baker, 1920, p. 257) may have been based on this form. Shimek does not list *ventricosa* from the Iowan loess and the species may not occur in Iowa. *Vertigo tridentata* Wolf bears some resemblance to *loessensis*, but does not have a basal fold, and some of the records of this species in Iowa may be referable to *loessensis*. *V. tridentata* has not been observed in the Pleistocene of Illinois.

POMATIOPSIS SCALARIS F. C. BAKER

Plate 32, figure 6

Pomatiopsis scalaris F. C. BAKER, *1927*, Nautilus, vol. 40, p. 119.

This species differs from the modern *Pomatiopsis lapidaria* (pl. 32, fig. 5 A, B) in its spire being generally longer with one more whorl, the body whorl shorter, wider, and more ventricose, the whorls more convex and the sutures deeper, the aperture rounder, and the umbilicus wider and deeper.

L. 7.8; D. 3.5; Ap. L. 2.1; D. 1.6 mm. Type.

L. 7.2; D. 3.5; Ap. L. 2.2; D. 1.8 mm. Paratype.

Type locality. New Harmony, Indiana, Posey County, U. of I. collection, P2321. Philadelphia Academy, 142713.

Horizon. Loess apparently of Peorian age.

This *Pomatiopsis* is characteristic of the loess and is widely distributed, both geographically and stratigraphically. Its geological distribution includes: Yarmouth loess, five exposures, 19 specimens; silt exposure 67 specimens; Early Wisconsin, loess, one exposure, twelve specimens, silt, one exposure, two specimens; aquatic exposures, three, 16 specimens.

In Illinois, *scalaris*, disappears in Early Wisconsin time and is replaced by *lapidaria*, which, however, is known in Arkansas from Yarmouth exposures and from Indiana from Sangamon exposures, the first locality represented by a few specimens, the latter by many. *Lapidaria* has not been observed in Peorian exposures but is more or less abundant

in the Early and Late Wisconsin. It is apparent, therefore, that there are two species in the Pleistocene, *scalaris*, with wide umbilical opening, occurring largely in loess deposits and less frequently in fluviatile deposits, and *lapidaria*, with a narrow umbilical opening, occurring in both terrestrial and aquatic deposits. *Lapidaria* and *scalaris* have been considered by some zoologists to be wholly terrestrial in habit and by others wholly aquatic. They are in fact amphibious species living at one time in water and at another on land. Their constant association with the little *Fossaria*, both in Pleistocene deposits and in the Recent fauna, indicates clearly their nature. That *P. scalaris* is rare in loess deposits also indicates that it is absent from places where there were wholly terrestrial conditions. *Pomatiopsis scalaris* is figured, under the name *lapidaria*, by Shimek, the specimen being from the type locality at New Harmony (1930, Pl. 11, fig. 22).

FOSSARIA PARVA TAZEWELLIANA (WOLF)
Plate 32, figures 11, A-C

Limnea tazewelliana WOLF, *1870*, Am. Jour. Conch., vol. 5, p. 198, pl. 17, fig. 2.

This species differs from the typical *parva* in having a longer, more turreted spire, rounder whorls and deeper sutures, and a smaller, generally rounder aperture.

L. 3/8 of an inch (about 9 mm.)	Wolf.
L. 6.5; D. 3.0; Ap. L. 2.4; D. 1.1 mm.	Fulton County, Peorian loess.
L. 5.7; D. 2.5; Ap. L. 1.6; D. 0.7 mm.	Fulton County, Peorian loess.

Type locality. Tazewell side, Illinois River, Illinois.

Horizon. Possibly Peorian loess.

Although an aquatic species of amphibious habits, this small lymnaeid occurs in such abundance in loess and other land deposits that it must be included in the loess fauna. Its geological distribution, as far as the museum records show, is as follows: Yarmouth loess, 8 exposures, land silt two exposures; fresh water deposit, one. Peorian loess, 22 exposures; silt, two exposures; Early Wisconsin, loess 5 exposures, silt 5 exposures; Late Wisconsin, one exposure. The total number of specimens of *tazewelliana* in the museum is nearly 500. Geographically, this race is known from Iowa and Illinois and it probably also occurs in Indiana.

Only an occasional specimen is found with the dimensions approaching those given by Wolf, the majority being from five to six mm. in length. Rarely a specimen occurs more than eight mm. in length. Typically *tazewelliana* is very distinct from *parva* (pl. 32, fig. 10 A-C) but

there are in most collections some specimens approaching *parva* and in some cases these variations would be classed as *parva* but for the presence of the *tazewelliana* form. The number of *parva*-like forms increases in later deposits and the Early Wisconsin collections show a mixture of the two forms. The specimens in all but one Late Wisconsin collection are referable to *parva*. No *tazewelliana*-like form has been observed in the Recent fauna. *Fossaria* and *Pomatiopsis scalaris*, are commonly but not invariably associated. *Fossaria* has been obtained from 39 per cent of the fossiliferous loess exposures, and is one of the most abundant species in some deposits. In the modern fauna, *Pomatiopsis lapidaria* occurs associated with *Fossaria parva* and *F. modicella*.

SPECIES AT PRESENT EXOTIC TO THE LOESS REGION

A distinct form of land snail *Oreohelix cooperi iowensis* (Pilsbry) more or less common in the loess of Iowa has been reported several times from Illinois. The reference by Baker (1922, p. 58) was based on fragments which are probably referable to *Polygyra multilineata wanlessi*. Three other references by Leverett, McGee, and Chamberlin and Salisbury, from Cass, Whiteside, and Carroll counties, are doubtful, since material from these counties recently examined has failed to disclose this species. It probably does not occur east of Iowa. Its nearest living relative is *Oreohelix cooperi stantoni* Dall, from Assiniboia, Canada. *Oreohelix cooperi limitaris* (Dawson), from Alberta, is also a similar form (Berry, 1922, p. 4). It is to be noted that both of these varieties now live far to the north of the localities at which *iowensis* occurs, in a climate much colder than that of Iowa today. Pilsbry says of *iowensis* (1916, p. 357), "It probably stands close to *stantoni*, which still exists in an environment perhaps not very unlike the loess climate of Iowa."

Several small species, mostly Pupillidae, occur abundantly in the loess and other land deposits of Illinois, but are absent from the Recent fauna. *Columella alticola* (Ingersoll) is abundant in deposits from Yarmouth to Early Wisconsin time and is recorded from the Aftonian near Rock Island, Illinois, by Leverett (Baker, 1920, p. 240). Its place is now taken by the common *Columella edentula* (Drap.) of the Palaearctic region, and *alticola* now lives in the west and south, Colorado, Wyoming, Utah, etc. *Vertigo modesta* (Say), now found living in the northern part of the United States and Canada, principally in the west and not known in Illinois, was abundant in the Pleistocene of Illinois and Iowa, occurring from Yarmouth to Early Wisconsin time. *Vallodia gracilicosta* Reinh. is abundant in the Pleistocene from Yarmouth to Early Wisconsin time,

and is recorded from the Aftonian of Iowa by Shimek. It now lives abundantly in western Iowa and more western localities.

A study of the Pleistocene faunas of Illinois brings out rather clearly the fact that the present living fauna equivalent to that of the different Pleistocene intervals of central and northern Illinois, and also the adjacent regions, is found far to the north and west of the Pleistocene geographic localities, and that if this ancient fauna lived under the same conditions, the climate was not only drier, at times, but also relatively cooler than is Illinois at the present time.

Bibliography

Baker, Frank Collins.

1906. A Catalogue of the Mollusca of Illinois. Bull. Ill. State Lab. Nat. Hist. VII, pp. 53-136.

1920a The Life of the Pleistocene or Glacial Period. University of Illinois Bulletin, XVII, No. 41, pp. i-iv, 1-476.

1920b Pleistocene Mollusca from Indiana and Ohio. Journal of Geol., XXVIII, pp. 439-457.

1920c Animal Life in Loess Deposits near Alton, Illinois, with descriptions of Two New Varieties of Land Shells from the same Deposits. Nautilus, XXXIV, pp. 61-68.

1922 Pleistocene Mollusca from Northeastern and Central Illinois. Journal of Geol., XXX, pp. 43-62.

1923. Pleistocene Mollusca from the Vicinity of Joliet, Illinois. Trans. Ill. State Acad. Sci., XV, pp. 408-420.

1927. Descriptions of New Forms of Pleistocene Land Mollusks from Illinois with remarks on other species. Nautilus, XL, pp. 114-120.

1928a. Molluscan Life of the Loess Deposits of Illinois. Trans. Ill. State Acad. Sci., XX, pp. 269-292.

1928b. Descriptions of New Varieties of Land and Fresh Water Mollusks from Pleistocene Deposits of Illinois. Nautilus, XLI, pp. 132-137.

1929. A Study of the Pleistocene Mollusca collected in 1927 from Deposits in Fulton County, Illinois. Trans. Ill. State Acad. Sci., XXI, pp. 288 312.

Berry, S. Stillman.

1922. Land Snails from the Canadian Rockies. Canada Dept. of Mines, Bull. 36. Biol. Series No. 8, pp. 1-17.

Clapp, George H.

1916. Notes on the Land-shells of the Islands at the Western End of Lake Erie and Descriptions of New Varieties. Ann. Carnegie Mus., XXI, pp. 532-540.

Pilsbry, Henry A.

1890a. Two New Species of U. S. Land Shells. Nautilus, IV, pp. 3-4.

1890b. New and Little Known American Mollusks, No. 3. Proc. Acad. Nat. Sci., Phil., pp. 296-302.

1908. Notes on Succinea ovalis Say and S. obliqua Say. Op. cit., pp. 45-51.

1916. Notes on the Anatomy of Oreohelix, with a Catalogue of the Species. Op. cit., pp. 340-359.

Shimek, B.

1901a. Pyramidula shimekii (Pilsbry), Shimek. Bull. Lab. Nat. Hist., Univ. Iowa, V, pp. 139-143.

1901b. The Loess of Iowa City and Vicinity. Op. Cit., pp. 195-212.
1904. Papers on the Loess. Op. Cit., pp. 289-381.
1913a. A New Succinea. Op. Cit., VI, pp. 31-34.
1913b. The Significance of Pleistocene Mollusks. Science, XXXVII, pp. 501-509.
1930. Land Shells as Indicators of Ecological Conditions. Ecology, XI, pp. 673-686.

WOLF, JOHN.
1870. Descriptions of Three New Species of Shells. Amer. Jour. Conch., V, p. 198.

PALEONTOLOGICAL NOTES

THE VALUE OF FOSSIL FRAGMENTS

JEROME S. SMISER
Princeton University, Princeton, New Jersey

Fragments of macrofossils are very conspicuous in washed concentrates of nearly all fossiliferous rocks. The fragments in some instances, as in certain levels of the Lower Cretaceous in Texas, constitute over 50 per cent of the total organic content of a concentrate[1]. Aside from the fragments contained in concentrates, other larger fragments can be collected from certain formations in the same manner as complete macrofossils are secured.

Paleontologists have described new forms and recognized old forms on the basis of fragments, but such cases are not common and only fragments which were obviously and unmistakeably those of a particular species are used. When the writer began his investigations on the value of fossil fragments, no exclusive work had been done in this line so far as he could determine. His investigations within the past three years have demonstrated that numerous genera and species of at least one group of macrofossils can be recognized from small fragments contained in washed concentrates, and that numerous other groups show possibilities of identification from fragments when studied in the same manner.

Obviously the index value of fossil fragments is equivalent to that of complete specimens, when they can be recognized as parts of previously described species whose range is known. The problem therefore, is the recognition of the fragments as parts of particular genera and species so that the information already available on the complete fossil can be applied to the fragment.

The first and most important step in learning to recognize fossil fragments is a thorough understanding of the details of the complete fossil. For instance in the few cases where fossils have been described as new or recognized as previously described species from fragments, they have been described or recognized, as a rule, by specialists on that particular group. The knowledge of the fossil must be sufficient to allow the investigator to assign any fragment found to some particular portion of the complete test. In doing this he can make use of generic and specific characters which show themselves to be constant and dependable. When the fragment cannot be placed in its proper relative position in the test, it is much less useful. In some cases the characters are the same that furnished the basis for the classification of the complete fossil, but in other instances new characters must be determined from complete fossils and in turn used to identify the fragments.

[1]The Fort Worth formation of the lower Washita group, Comanche series.

The fragments of only one group of fossils have been studied in detail by the writer, those of the echinoids which occur in the Cretaceous rocks of Texas. This study has demonstrated that nearly all of the genera and many of the species of Texas Cretaceous echinoids can be recognized from small fragments or plates from the test. The echinoids were selected for investigation due to: (1) their abundance and importance in certain Cretaceous formations in Texas, and (2) the fact that each portion of the test is a unit and usually carries some distinctive character of the complete fossil. In using plates from the test of an echinoid, the ambulacral plates which are perforated for the extension of the tube feet, are most useful. Interambulacral plates and spines are secondary in importance and less reliable for determining the species.

A complete specimen of *Holaster simplex* Shumard is a large echinoid with the tubercles scattered in the interambulacral areas and absent from ambulacral grooves. The ambulacral grooves contain plates which are perforated by a slit pore-pair set very low in each plate. The scattered nature of the tubercles, the size and shape of the plate and their granular appearance make recognition of the interambulacral plates of this form possible. Ambulacral plates are recognized by the slit-like character of the ambulacral pores, their position in the plate, and the lack of granules in ambulacral plates. Spines are recognized by general shape and by the presence of smooth longitudinal ridges. These spines have been discovered actually in place on complete specimens and fragments.

Many other groups of fossils furnish recognizable fragments. Some furnish large fragments which are as readily recognized as the complete fossils. For example most of the ammonite remains found in the Cretaceous rocks of many areas are fragments, but they are so nearly complete, or carry such diagnostic characters that they can be recognized quite readily. The fragments of the genera *Engonoceras*, *Oxytropidoceras*, *Hamites* and others which show the type of ornamentation and the suture pattern are of nearly the same value to an ammonite specialist as the complete fossil.

Nearly any fossil which has a distinctive type of ornamentation may be recognized from only a very small fragment such as would come from well cuttings. Even certain of the very common pelecypods and gastropods can be recognized from pieces. In the Cretaceous rocks of Texas the pelecypods of the genera *Alectryonia*, *Trigonia* and *Protocardia* all have sufficiently characteristic and persistent types of ornamentation so that their fragments are recognizable. Even the pectens, many of which are extremely similar, furnish some species whose fragments can be used. The ribbing on *Pecten bellula* Cragin from the Fort Worth formation of the Texas Cretaceous, for example, is so fine and characteristic that even an extremely small piece can be recognized as part of that species.

In some genera, such as *Exogyra* from the Texas Cretaceous, only certain portions of the test will allow specific determinations. *Exogyra arietina* Roemer from the Del Rio and Grayson formations particularly, can be recognized when the fragment is the beak or a portion of it.

[1] "A Study of the Echinoid Fragments in the Cretaceous Rocks of Texas," at present in the hands of the publication committee, Bureau of Economic Geology, University of Texas, for approval and publication.

One other common and noteworthy fragment found in nearly all of the world where Cretaceous rocks exist is the *Inoceramus* prism. This genus, which includes a great many species, is a characteristic Cretaceous clam and has a very wide distribution. The writer has found the calcite prisms which make up the tests of the species of this genus in rocks of Cretaceous age from Texas, Wyoming, New Jersey, and from material of Cretaceous age from western Africa. A thorough study of the genus and its fragments might result in a determination of species from the prisms and other parts.

Only a few of the fossils which can be recognized from fragments have been mentioned. A great many more exist and it is hoped that the mention of these few and the suggested plan of procedure may stimulate more interest in the study of fossil fragments.

NEW INFORMATION ON THE BASE OF THE PERMIAN IN NORTH-CENTRAL TEXAS

ROBERT ROTH
Bartlesville, Oklahoma

During recent stratigraphic studies of the Pennsylvanian and Permian in north-central Texas, the writer had occasion to make paleontological collections from Drake's No. 2 bed of the Waldrip, or the Crystal Falls limestone of Plummer and Moore. The collections were made on the highway between Brownwood and Coleman, 2.8 miles west of the east county line of Colemen County, and about 0.5 miles north of the highway.

The fossils collected consisted of the following fusulinids: *Pseudofusulina longissimoidea*, *P. forakerensis*, *Triticites tumidus*, *T. ventricosus*, and *T. koschmanni*. This faunule is characteristic of the Neva limestone in Oklahoma and Kansas, and marks the base of Permian environment in the sense of the term as used by Dr. Beede. Diligent search was made on the outcrop for *Schwagerina*, but without success. This, however, is not surprising since *Schwagerina* is extremely scarce in the Neva limestone where its occurrence is sporadic. The writer believes, however, that its presence in the Crystal Falls limestone will be disclosed by further and more careful search. The above species were checked by Mr. Skinner against the forms which he has found in the Neva. This definitely lowers the base of the Permian as indicated by fusulinids some 700 feet in this region.